Fisher® 4194HA, HB, and HC Differential Pressure Indicating Controllers

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Section 1

Introduction

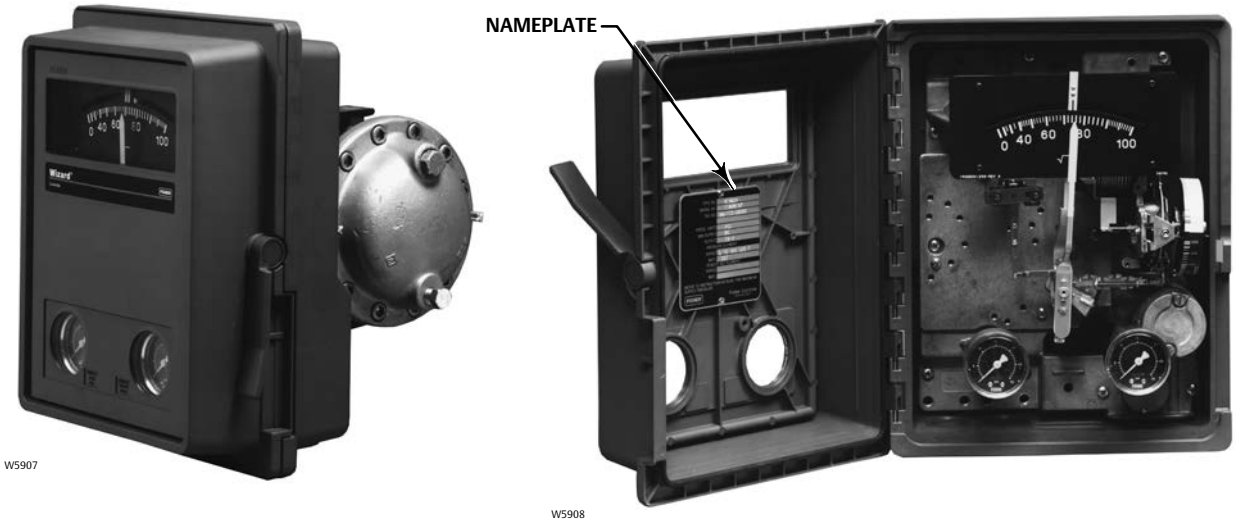
Scope of Manual

This instruction manual provides installation, operating, calibration, maintenance, and parts ordering information for the 4194HA, HB, and HC (high static pressure) differential pressure indicating controllers.

Portions of this manual apply only to specific 4194HA, HB, and HC controller configurations. These configurations are indicated by letter suffixes in the type number that correspond to the mode and option designated in table 1-2.

The specific controller type number (with letter suffixes) is located on the nameplate (figure 1-1). Refer to table 1-2 for the definition of each 4194H controller type number.

Figure 1-1. Fisher 4194H Differential Pressure Controller



Do not install, operate, or maintain a 4194HA, HB, or HC controller without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office before proceeding.

Description

The controllers described in this manual provide differential control with options as shown in table 1-2.

- 4194HA controllers: Proportional-only control
- 4194HB controllers: Proportional-plus-reset control
- 4194HC controllers: Proportional-plus-reset-plus-rate control

4194HA, HB, or HC controllers show process differential pressure and set point on an easy-to-read process scale. The controller output is a pneumatic signal that operates a final control element.

Specifications

Specifications for 4194HA, HB, and HC controllers are listed in table 1-1.

Educational Services

For information on available courses for 4194HA, 4194HB, and 4194HC controllers, as well as a variety of other products, contact:

Emerson Process Management
Educational Services, Registration
Phone: +1-641-754-3771 or +1-800-338-8158
e-mail: education@emerson.com
http://www.emersonprocess.com/education

Table 1-1. Specifications

Available Configurations

See table 1-2

Input Signal (Differential Pressure Sensing Element Range)

Differential Pressure Range: See table 1-3
Maximum Safe Working Pressure: See table 1-3

Output Signal

Proportional-Only, Proportional-Plus-Reset, or Proportional-Plus-Reset-Plus-Rate Range: 0.2 to 1.0 bar (3 to 15 psig) or 0.4 to 2.0 bar (6 to 30 psig)

Action: Field-reversible between direct(1) (increasing differential pressure increases output pressure) or reverse(1) (increasing differential pressure decreases output pressure)

Process Scale

Standard scale is matched to the range of the differential pressure sensing element. Linear, square root, and optional scales(2) available

Process Connections (To Differential Pressure Unit)

Standard: 1/4 NPT internal stainless steel (all input ranges)

Optional: 1/2 NPT internal stainless steel

Supply And Output Connections

1/4 NPT internal

Supply Pressure Requirements

See table 1-4

Supply Pressure Medium

Air or natural gas

Air: Supply pressure must be clean, dry air that meets the requirements of ISA Standard 7.0.01.

Natural Gas: Natural gas must be clean, dry, oil-free, and noncorrosive. H_2S content should not exceed 20 ppm.

A maximum 40 micrometer particle size in the air system is acceptable. Further filtration down to 5 micrometer particle size is recommended. Lubricant content is not to exceed 1 ppm weight (w/w) or volume (v/v) basis. Condensation in the air supply should be minimized.

Remote Set Point Pressure Ranges

0.2 to 1.0 bar (3 to 15 psig) or
0.4 to 2.0 bar (6 to 30 psig)

Controller Adjustments

Proportional Band: 5 to 500% of process scale range

Reset: Adjustable from 0.01 to more than 74 minutes per repeat (from 100 to less than 0.0135 repeats per minute)

Rate: Adjustable from 0 to 20 minutes

Set Point: Continuously adjustable from 0 to 100% of the scale range

Controller Performance

Repeatability: 0.4% of output span

Dead Band: Less than 0.2% of process scale range

Steady-State Air Consumption(3)

Without Auto/Manual Station

0.2 to 1.0 Bar (3 to 15 Psig) Output:
0.09 m^3/hr (3.5 scfh)

0.4 to 2.0 Bar (6 to 30 Psig) Output:
0.13 m^3/hr (5.0 scfh)

With Auto/Manual Station (suffix letter E)

0.2 to 1.0 Bar (3 to 15 Psig) Output:
0.28 m^3/hr (10.0 scfh)

2.0 to 4.0 Bar (6 to 30 Psig) Output:
0.28 m^3/hr (10.0 scfh)

Delivery Capacity(3)

0.2 to 1.0 Bar (3 to 15 Psig) Output:
6.4 m^3/h (240 scfh)

0.4 to 2.0 Bar (6 to 30 Psig) Output:
9.4 m^3/h (370 scfh)

Exhaust Capacity(3)

0.2 to 1.0 Bar (3 to 15 Psig) Output:
5.0 m^3/h (186 scfh)

0.4 to 2.0 Bar (6 to 30 Psig) Output:
7.9 m^3/h (295 scfh)

Operative Ambient Temperature Limits(4)

–40 to 70°C (–40 to 160°F)

-continued-

Table 1-1. Specifications (continued)

Hazardous Area Classification

Complies with the requirements of ATEX Group II Category 2 Gas and Dust

CE ⟨Ex⟩ II 2 G D

Housing

Designed to NEMA 3 and IEC 529, IP54 specifications

Mounting

Controller is mounted on a pipestand. See figure 2-1.

Approximate Weight

Controller: 4.5 kg (10 lb) without the differential pressure unit

Differential Pressure Unit: 21.5 kg (47 lb)

Total Weight (controller and differential pressure unit): 26 kg (57 lb) (with a Barton 199 Differential Pressure Unit)

Declaration of SEP

Fisher Controls International LLC declares this product to be in compliance with Article 3 paragraph 3 of the Pressure Equipment Directive (PED) 97 / 23 / EC. It was designed and manufactured in accordance with Sound Engineering Practice (SEP) and cannot bear the CE marking related to PED compliance.

However, the product *may* bear the CE marking to indicate compliance with *other* applicable EC Directives.

NOTE: Specialized instrument terms are defined in ANSI/ISA Standard 51.1 − Process Instrument Terminology.
1. With Barton 199 differential pressure unit. For ranges other than those listed in table 1-3, contact your Emerson Process Management sales office.
2. Consult your Emerson Process Management sales office for additional information.
3. Normal m^3/hr: normal cubic meters per hour (0°C and 1.01325 bar absolute). Scfh: standard cubic feet per hour (60°F and 14.7 psia).
4. Also for transportation and storage limits.

Table 1-2. Available Configurations

CONTROLLER(1)		MODES			OPTIONS		
		Proportional-Only	Proportional-Plus-Reset	Proportional-Plus-Reset-Plus-Rate	Anti-Reset Windup	Remote Set Point	Internal Auto/ Manual Station
4194HA	4194HA	X					
	4194HAE	X					X
	4194HAM	X				X	
	4194HAME	X				X	X
4194HB	4194HB		X				
	4194HBE		X				X
	4194HBF		X		X		
	4194HBFE		X		X		X
	4194HBM		X			X	
	4194HBME		X			X	X
	4194HBFM		X		X	X	
	4194HBFME		X		X	X	X
4194HC	4194HC			X			
	4194HCE			X			X
	4194HCF			X	X		
	4194HCFE			X	X		X
	4194HCM			X		X	
	4194HCME			X		X	X
	4194HCFM			X	X	X	
	4194HCFME			X	X	X	X

1. Reverse-acting constructions are designated by an R added to the type number.

Table 1-3. Process Sensor (Barton 199) Range and Pressure Ratings

DIFFERENTIAL PRESSURE RANGE(1)		SAFE WORKING PRESSURE(2)		HOUSING MATERIAL
		Bar	Psig	
Psig (bar)	0 to 15 (0 to 1) 0 to 30 (0 to 2) 0 to 40 (0 to 2.8) 0 to 50 (0 to 3.4) 0 to 60 (0 to 4) 0 to 75 (0 to 5)	68.9	1000	Stainless steel
	0 to 15 (0 to 1) 0 to 30 (0 to 2) 0 to 40 (0 to 2.8) 0 to 50 (0 to 3.4) 0 to 60 (0 to 4) 0 to 75 (0 to 5)	172	2500	Steel
	0 to 15 (0 to 1) 0 to 30 (0 to 2) 0 to 40 (0 to 2.8) 0 to 50 (0 to 3.4) 0 to 60 (0 to 4) 0 to 75 (0 to 5)	414	6000	Steel
Inches w.c. (mbar)	0 to 20 (0 to 50) 0 to 25 (0 to 62) 0 to 50 (0 to 124) 0 to 75 (0 to 186) 0 to 100 (0 to 248)	68.9	1000	Stainless steel
	0 to 20 (0 to 50) 0 to 25 (0 to 62) 0 to 50 (0 to 124) 0 to 75 (0 to 186) 0 to 100 (0 to 248)	172	2500	Steel
	0 to 20 (0 to 50) 0 to 25 (0 to 62) 0 to 50 (0 to 124) 0 to 75 (0 to 186) 0 to 100 (0 to 248)	414	6000	Steel

1. Differential pressure ranges are in English units of measurement; metric equivalents are shown here for reference only. Consult your Emerson Process Management sales office for special differential pressure ranges.
2. The Barton 199 differential pressure unit may be pressured to this value without permanent zero shift or structural damage to controller components.

Table 1-4. Supply Pressure Requirements

Output Signal Range		Normal Operating Supply Pressure (1)	Maximum Pressure to Prevent Internal Damage(2)
Bar	0.2 to 1.0	1.4	2.8
	0.4 to 2.0	2.4	2.8
Psig	3 to 15	20	40
	6 to 30	35	40

1. If this pressure is exceeded, control stability may be impaired.
2. If this pressure is exceeded, damage to the controller may result.

Section 2

Installation, Mounting, and Connections

⚠ WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure:

- **Always wear protective clothing, gloves, and eyewear when performing any installation operations.**
- **Personal injury or property damage may result from fire or explosion if natural gas is used as the supply medium and preventive measures are not taken. Preventive measures may include, but are not limited to, one or more of the following: Remote venting of the unit, re-evaluating the hazardous area classification, ensuring adequate ventilation, and the removal of any ignition sources. For information on remote venting of this controller, refer to page 11.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**
- **If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section of this instruction manual.**

Controller Mounting Orientation

Mount the controller with the housing vertical, as shown in figure 2-1, so the vent points down.

Pipestand Mounting

A 4194H controller mounts on a pipestand. Install with the vent opening facing down. Secure the mounting coupling to the pipestand by three set screws as shown in figure 2-1.

Pressure Connections

⚠ WARNING

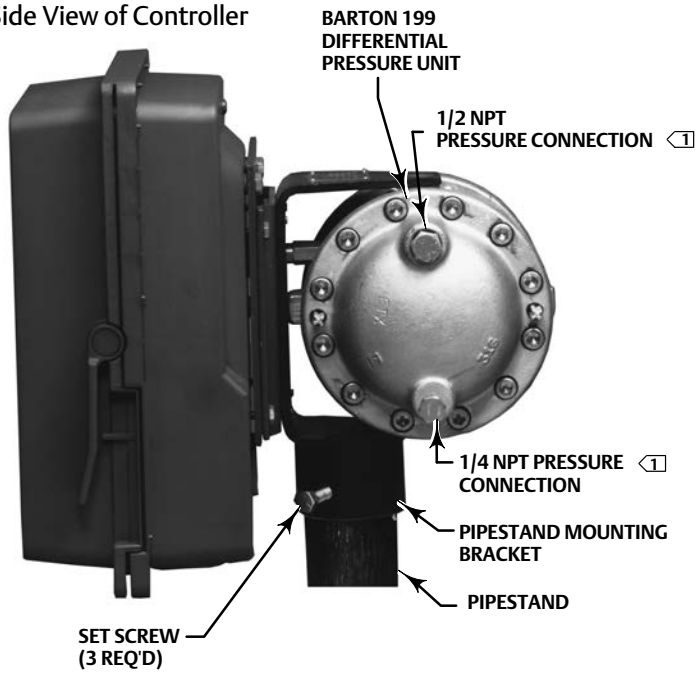
To avoid personal injury or property damage resulting from the sudden release of pressure, do not install any system component, including the differential pressure unit, where service conditions could exceed the limits given in this manual. Use pressure-relieving devices as required by government or accepted industry codes and good engineering practices.

Refer to figures 2-1, 2-2, and 2-3 for the location of all input and output connections for the controller and differential pressure unit. Also, refer to the differential pressure unit instruction manual for specific information about connections and piping.

Supply, output, vent, and remote set point connections are 1/4 NPT. Use 1/4 or 3/8-inch pipe or tubing for supply, output, vent, and remote set point piping.

Process pressure connections are 1/4 or 1/2 NPT (optional). When installing process piping to the differential pressure unit attached to the controller, follow accepted engineering, installation, and safety practices to insure the safe and accurate transmission of the process differential pressure to the differential pressure unit. Install shutoff valves, vents, drains, or seal systems as required by accepted practices.

Figure 2-1. Right Side View of Controller



NOTE:
1 LOW PRESSURE CONNECTION ON A BARTON 199 DIFFERENTIAL PRESSURE UNIT.

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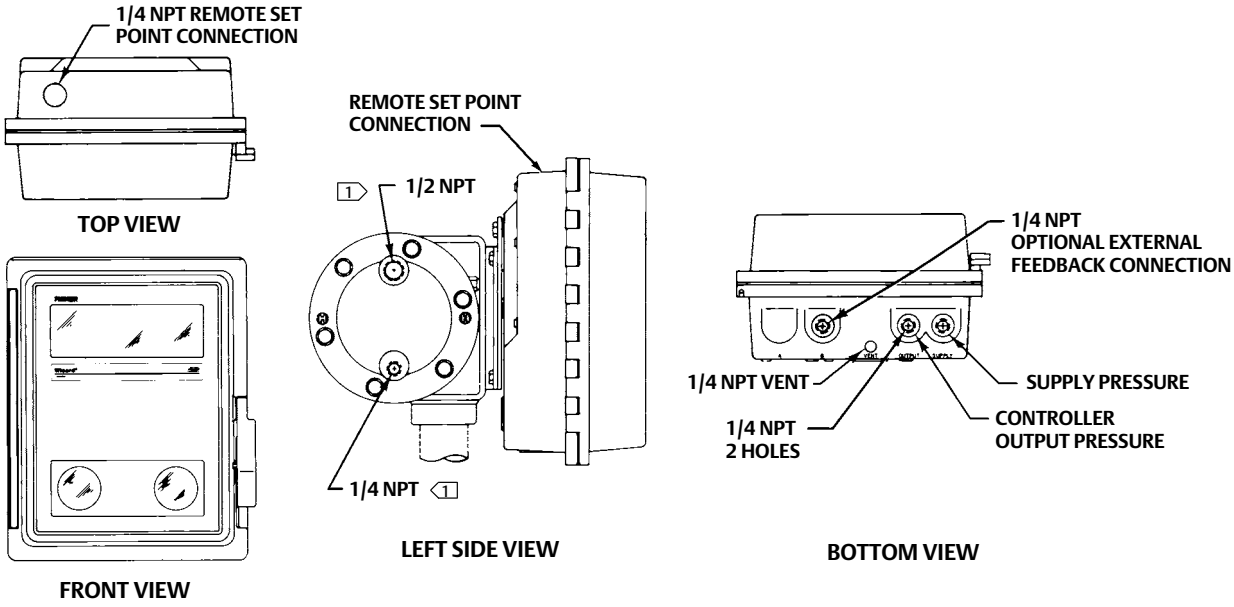
Figure 2-2. Connections



NOTE:
1 HIGH PRESSURE CONNECTION ON A BARTON 199 DIFFERENTIAL PRESSURE UNIT.

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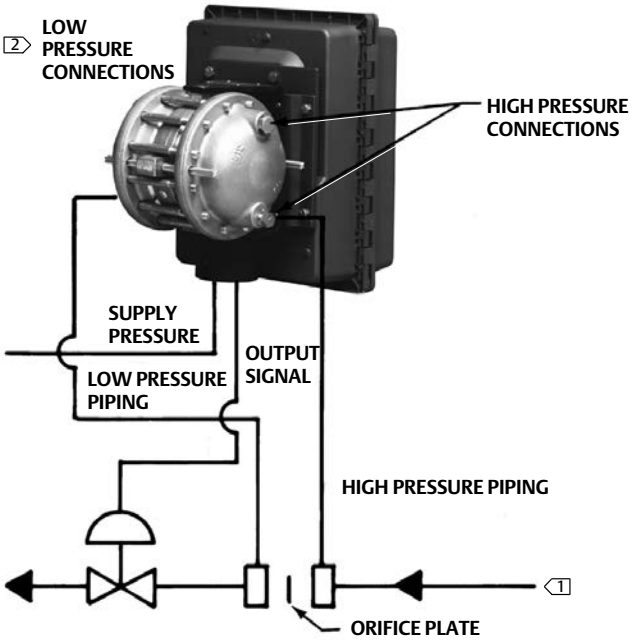
Process Pressure Connections

Process pressures are piped to the connections on the ends of the differential pressure unit (figure 2-3). Refer to the differential pressure unit instruction manual for the high and low pressure connections.

Figure 2-3. Simplified Control Loop Diagram



NOTE:
1 TO ALLOW A REAR VIEW OF THE CONTROLLER/DIFFERENTIAL PRESSURE UNIT, THE SCHEMATIC SHOWS PROCESS FLOW FROM RIGHT TO LEFT.
2 SEE FIGURE 2-1 FOR LOW PRESSURE CONNECTIONS.

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When installing process piping, follow accepted practices to ensure accurate transmission of the process pressures to the differential pressure unit. Install a three-valve bypass, shutoff valves, vents, drains, or seal systems as needed in the process pressure lines.

If the instrument is located such that the adjacent process pressure lines will be approximately horizontal, the lines should slope downward to the instrument for liquid-filled lines and upward toward the instrument for gas-filled lines. This will reduce the chance of air becoming trapped in the sensor with liquid-filled lines or of condensate becoming trapped with gas-filled lines. The recommended slope is 83 millimeters per meter (1 inch per foot).

Supply Pressure

⚠ WARNING

Severe personal injury or property damage may occur if the instrument supply medium is not clean, dry air or oil-free, noncorrosive gas. While use and regular maintenance of a filter that removes particles larger than 40 micrometer in diameter will suffice in most applications, check with an Emerson Process Management field office and industry instrument air quality standards for use with corrosive gas or if you are unsure about the proper amount or method of air filtration or filter maintenance.

Supply pressure must be clean, dry air or noncorrosive gas that meets the requirements of ISA 7.0.01. A maximum 40 micrometer particle size in the air system is acceptable. Further filtration down to 5 micrometer particle size is recommended. Lubricant content is not to exceed 1 ppm weight (w/w) or volume (v/v) basis. Condensation in the air supply should be minimized. Natural gas must be clean, dry, oil-free, and noncorrosive. H_2S content should not exceed 20 ppm.

Use a suitable supply pressure regulator to reduce the supply pressure source to 1.4 bar (20 psig) for an output signal range of 0.2 to 1.0 bar (3 to 15 psig) and to 2.4 bar (35 psig) for an output signal range of 0.4 to 2.0 bar (6 to 30 psig).

Vent Connection

⚠ WARNING

Personal injury or property damage could result from fire or explosion of accumulated gas, or from contact with hazardous gas, if a flammable or hazardous gas is used as the supply pressure medium. Because the controller case and cover assembly do not form a gas-tight seal when the assembly is enclosed, a remote vent line, adequate ventilation, and necessary safety measures should be used to prevent the accumulation of flammable or hazardous gas. However, a remote vent pipe alone cannot be relied upon to remove all flammable or hazardous gas. Vent line piping should comply with local and regional codes and should be as short as possible with adequate inside diameter and few bends to reduce case pressure buildup.

CAUTION

When installing a remote vent pipe, take care not to over-tighten the pipe fitting in the vent connection. Excessive torque will damage the threads in the connection.

If a remote vent is required, the vent line must be as short possible with a minimum number of bends and elbows. Vent line piping should have a minimum inside diameter of 19 mm (3/4 inches) for runs up to 6.1 m (20 feet) and a minimum inside diameter of 25 mm (1 inch) for runs from 6.1 to 30.5 m (20 to 100 feet).

If a remote vent is not required, the vent opening (figure 2-2) must be protected against the entrance of any foreign material that could plug it. Check the vent periodically to be certain it is not plugged.

Remote Set Point (suffix letter M) Connection

If the controller has the remote set point option, connect the remote set point pressure to the top of the controller case at the location shown in figure 2-2. If pressure is supplied to the remote set point connection with a regulator, a small bleed orifice should be placed between the regulator and remote set point connection to prevent pressure variations due to regulator lock-up.

External Feedback Connections (4194HB Controllers Only)

When a secondary controller in an override application has this option, reset windup is minimized in the secondary controller. Connect the external feedback connection of the secondary controller to the output of the customer-supplied high or low select relay. See figure 2-2.

Section 3

4194HA Proportional-Only Controllers

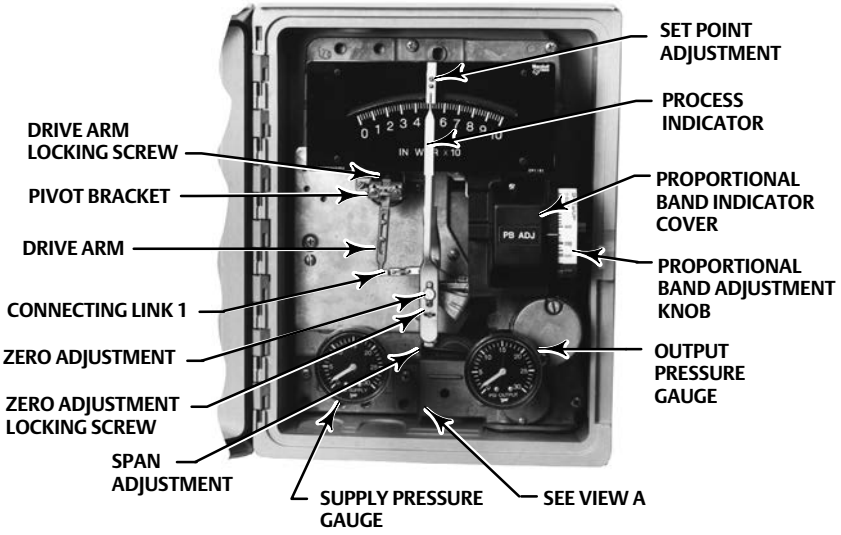
Adjustments for 4194HA Controllers

Note

Some of the following procedures require adjusting the proportional band knob between DIRECT and REVERSE. If this is done, it will be necessary to set the proportional band knob to 400 (direct or reverse action) before replacing the proportional band indicator cover.

This section includes descriptions of adjustments and procedures for prestartup and startup. Location of adjustments is shown in figure 3-1. To better understand the adjustments and overall operation of the controller, refer to the principle of operation and the schematic diagrams (figures 3-3, 4-2, and 4-3). Unless otherwise noted, refer to figure 6-1 for key number locations.

Figure 3-1. Location of Controller Parts and Adjustments



FRONT VIEW

NOTE:
1 ON CONTROLLERS EQUIPPED WITH REMOTE SET POINT OPTION, THIS IS THE REMOTE SET POINT INDICATOR.

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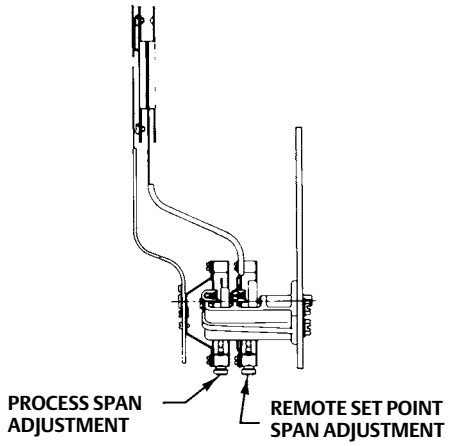

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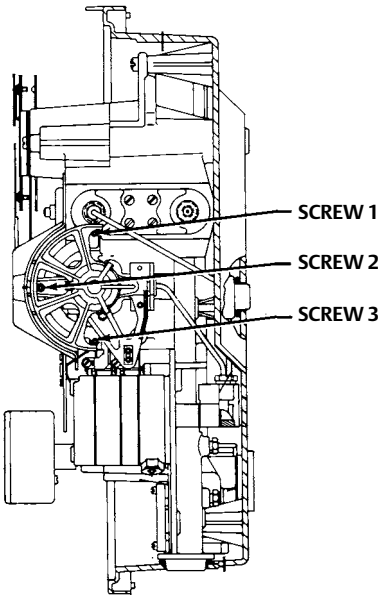
SIDE VIEW OF SET POINT / PROCESS INDICATOR ASSEMBLY



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SIDE VIEW OF CONTROLLER SHOWING FLAPPER LEVELING SCREWS

Manual Set Point Adjustment

To adjust the set point, open the controller cover and move the set point indicator until the desired value on the process differential pressure scale is below the line on the set point indicator. Move the adjustment to the right to increase the set point and to the left to decrease it.

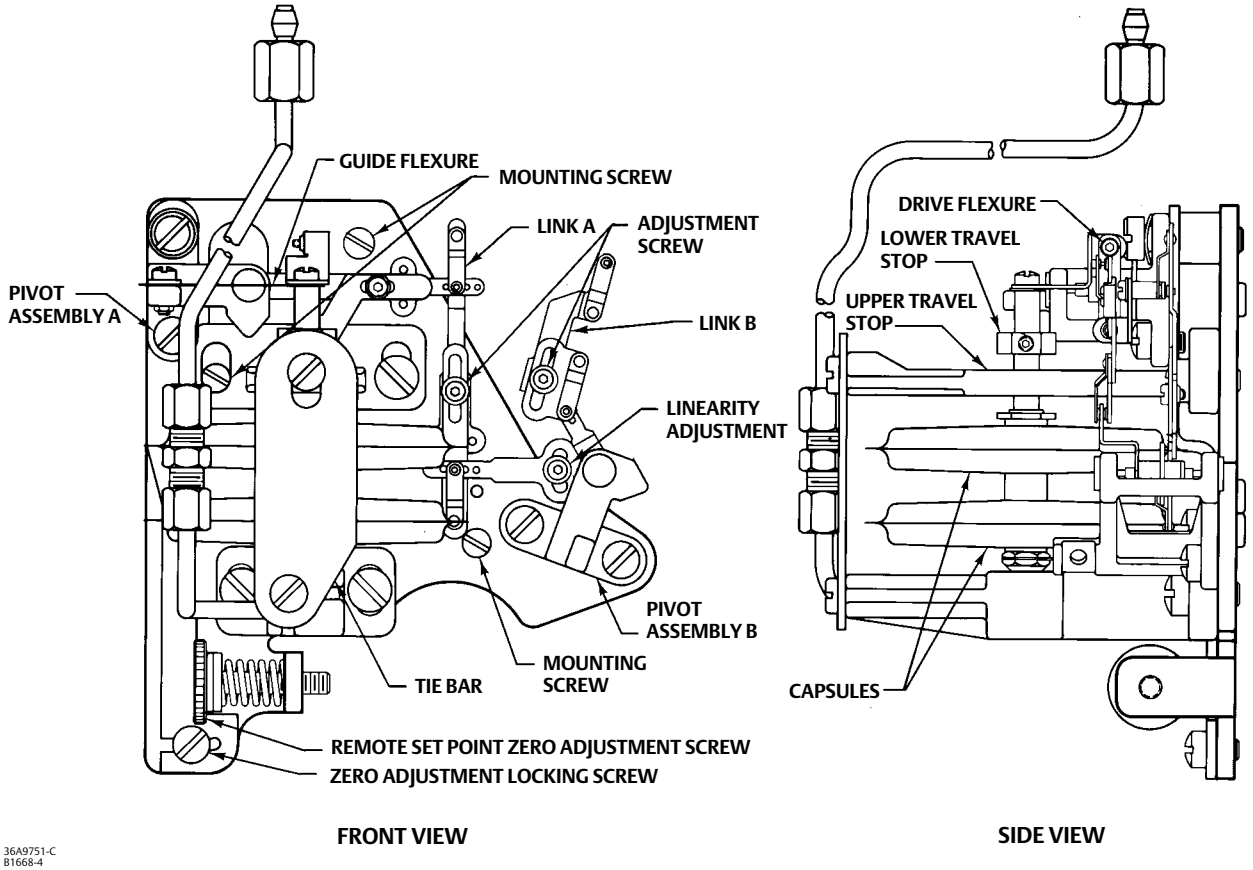
Remote Set Point (suffix letter M) Adjustment

CAUTION

Do not manually move the set point indicator on controllers with remote set point. Moving the set point indicator could damage the controller.

If the controller is equipped with the remote set point option (figure 3-2), vary the remote set point pressure to change the set point. Increase the pressure to increase the set point and decrease the pressure to decrease the set point.

Figure 3-2. Parts and Adjustments, Remote Set Point Option



Proportional Band Adjustment (PB ADJ)

The proportional band adjustment determines the output sensitivity of the controller. The proportional band knob is marked in percentages of process differential pressure required to drive the controller from zero output to full output.

For example, a typical 4194H unit offers 0.2 to 1.0 bar (3 to 15 psig) output. Furthermore, this controller comes equipped with a differential pressure unit capable of sensing a process pressure differential ranging from 0 to 1.0 bar

(0 to 15 psig). Then, at a proportional band setting of 100 percent DIRECT, the controller output goes from 3 to 15 psig as the process pressure differential goes from 0 to 15 psig. If the proportional band setting is subsequently changed to 50 percent DIRECT, the controller output would change from 3 to 15 psig as the process pressure differential changed from 0 to 7.5 psig.

Adjusting the proportional band has minimal effect on the set point.

Changing Controller Action

Controller action is switchable from direct to reverse or vice versa by simply loosening the screws on the proportional band indicator cover and moving the cover out so the proportional band knob can be rotated to the desired action. The white portion of the adjustment enables direct controller action. The black portion enables reverse controller action.

Switching The Auto/Manual Station (suffix letter E)

Note

Switching the controller between automatic and manual mode without balancing can disturb the process and cause controller cycling.

Refer to figure 6-5 if the controller has the auto/manual option.

To switch from automatic to manual mode, you must balance the manual output with the controller output.

Two balance methods are available to equalize the manual output with the controller output.

To switch from automatic to manual mode, carefully adjust the loader knob until the metal ball inside the plastic tube moves into the switching zone. Then move the automatic/manual switch to MANUAL. Turn the loader knob clockwise to increase the controller output or counterclockwise to decrease it.

To switch from manual to automatic mode, adjust the set point manually or with remote set point pressure to move the ball into the switching zone. Turn the switch to AUTOMATIC and adjust the set point manually or with remote set point pressure to control the output.

When the automatic/manual switch is in AUTOMATIC, adjusting the loader knob has no effect on the controller output. When the automatic/manual switch is in MANUAL, changing the set point adjustment has no effect on the controller output.

Prestartup Checks for 4194HA Controllers

Refer to figure 3-1 for location of adjustments and refer to figure 6-1 for location of key numbers.

When performing the checks, open loop conditions must exist. An open loop exists when the controller output does not affect the input pressure or other control signal to the controller.

Note

If the controller has the auto/manual option (suffix letter E), be sure the controller is in the automatic mode before performing the prestartup checks.

1. Connect supply pressure to the supply pressure regulator and be sure it is delivering the proper supply pressure to the controller. Provide a means of measuring the controller output pressure. Also, provide a means of applying process differential pressure to the differential pressure unit.
2. For a controller with remote set point (suffix letter M), connect regulated pressure of 0.2 to 1.0 bar (3 to 15 psig) or 0.4 to 2.0 bar (6 to 30 psig) to the remote set point connection at the top of the controller case.
3. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Set the proportional band between DIRECT and REVERSE.
5. Adjust the process differential pressure until the controller indicates 50 percent of the input range. The process indicator should point out the process differential pressure within ±1 percent of the input span.
6. If the process indicator is out of calibration, refer to the process indicator zero-and-span adjustment procedures in the Calibration section. Also, check the accuracy of the process indicator at other points on the scale.
7. For controllers with manual set point, move the set point indicator to 50 percent of the scale range. For controllers with remote set point (suffix letter M), adjust the remote set point pressure until the set point moves to 50 percent of the scale range.
8. The output of the controller should be:
   - 0.62 ±0.007 bar (9 ±0.1 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output
   - 1.2 ±0.01 bar (18 ±0.2 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output
9. Adjust the proportional band to 20 percent DIRECT. The output of the controller should remain essentially the same.
   - 0.62 ±0.017 bar (9 ±0.25 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output
   - 1.2 ±0.03 bar (18 ±0.5 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output
10. Adjust the proportional band to 20 percent REVERSE. The output of the controller should remain essentially the same.
    - 0.62 ±0.017 bar (9 ±0.25 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output
    - 1.2 ±0.03 bar (18 ±0.5 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output
11. If the controller output is out of tolerance in steps 8, 9, or 10, the flapper needs to be aligned. Refer to the flapper alignment procedure.
12. If the controller output is within tolerance, replace the proportional band cover and go to the startup procedure.

Startup for 4194HA Controllers

Perform the prestartup checks and, if necessary, calibrate the controller prior to this procedure.

Note

When performing the startup procedure, keep in mind the initial settings are guidelines. They will vary depending on the actual process being controlled.

1. Be sure the supply pressure regulator is delivering the proper supply pressure to the controller.
2. For controllers with:
   - manual set point:

Move the set point indicator to the desired set point.

- remote set point:

  a. See figure 2-2 for the location of the remote set point connection. Connect an adjustable pressure source to the remote set point connection.

  b. Adjust the pressure source until the set point indicator reaches the desired set point. Remember: Increasing the remote set point pressure increases the set point of direct-acting controllers.

3. Set the proportional band adjustment to 100 percent for fast processes. For slow processes, calculate the proportional band percentage from the equation below:

$$\text{Proportional Band Adjustment} = \frac{200 \times \text{Allowable Overshoot}}{\text{Pressure Span}}$$

For example:

$$\frac{200 \times 2 \text{ Psig}}{30 \text{ Psig}} \cong 13\%$$

4. Create a load upset by momentarily changing the set point. Check for system cycling. If the system does not cycle, lower the proportional band setting (thus raising the gain) and disturb the system again by changing the set point. Continue this procedure until the system cycles. At this point, double the proportional band setting (proportional band setting X 2).

Calibration for 4194HA Controllers

⚠ WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure, do not exceed the operating limits given in this manual.

General Calibration Instructions

Note
If the controller has the auto/manual option, be sure the controller is in the automatic mode before performing calibration.

If the prestartup checks revealed faulty controller operation, perform the calibration described in this section. These instructions are valid for either shop or field calibration, provided open process loop conditions exist. Unless otherwise noted, key numbers are found in figure 6-1.

Process Indicator Zero-and-Span Calibration

Before starting this procedure:

- Provide a regulated process differential pressure to the differential pressure unit.
- Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-4.

Note
Any change in process indicator span will require readjustment of the process indicator zero adjustment screw.

Refer to figure 3-1 for location of adjustments.

1. Remove two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. The process indicator should be aligned with the indicator subassembly as shown in figure 5-6. If not, loosen the zero adjustment locking screw and adjust the fine zero adjustment to align the process indicator and indicator subassembly. See figure 6-4.
4. Adjust the process differential pressure until the controller indicates 50 percent of the input range.
5. The process indicator should point to 50 percent of the process scale range. If not, loosen the drive arm locking screw (key 331, figure 6-2) that holds the drive arm (key 322) to the shaft extension (key 321) and readjust the drive arm on the shaft until the process indicator points to 50 percent of the process scale range. Tighten the drive arm locking screw.
6. Adjust the process differential pressure to the lower limit of the input span. Note the position of the process indicator.
7. If necessary, adjust the process indicator to the lowest limit of the input scale by loosening the zero adjustment locking screw and turning the zero adjustment screw.
8. Adjust the process differential pressure to the upper limit of the input span. Note whether the process indication is above or below the upper limit of the process scale.
9. Adjust the span screw as follows: Clockwise to increase span for a low indication or counterclockwise to decrease span for a high indication. Adjust the span screw to correct one-half the error.
10. Repeat steps 6 through 9 until the error is eliminated.
11. Adjust the process differential pressure to 50 percent of the input range. The process indicator should point to the mid-scale value within ±1 percent of the input span. If the process indicator does not point to the proper value, select the appropriate instructions, below:

    - If the process indicator error at mid-range is greater than ±1 percent but not greater than ±2 percent, turn the zero adjustment screw to bring the process indicator within ±1 percent at mid-range. Then, check the process indicator accuracy at the lower and upper scale limits, to verify it is within ±1 percent of the input span.

      After adjusting the process indicator to ±1 percent at the low, mid-range, and upper scale limits, proceed with step 12.

    - If the process indicator error at mid-range is greater than ±2 percent, loosen the two screws in the drive arm (key 322, figure 6-2) and lengthen or shorten the drive arm approximately 6.3 mm (1/4-inch). Then, repeat steps 6 through 11.

      After adjusting the process indicator to ±1 percent at the low, mid-range, and upper scale limits, proceed with step 12.

12. Perform the flapper alignment procedure. Install the proportional band indicator cover (key 36) and tighten the two screws (key 6).

Remote Set Point (suffix letter M) Zero-and-Span Adjustment

Refer to figure 3-1 for location of adjustments. Refer to figures 6-1 and 6-2 for key number locations.

Note

Any adjustment of the set point span adjustment screw will require readjustment of the set point zero adjustment screw. Refer to figure 3-1.

1. Remove two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Adjust the set point pressure to the low limit of the set point input range. Note the position of the set point indicator. Loosen the set point zero adjustment locking screw and adjust the zero adjustment screw (figure 3-1) until the set point indicator aligns with the lowest scale limit.

   When the set point indicator is properly aligned with the low scale limit, tighten the zero adjustment locking screw.
4. Adjust the set point pressure to the upper limit of the input span. Note whether the indication is above or below the upper limit of the process scale.
5. Adjust the span screw as follows: Clockwise to increase span for a low indication; counterclockwise to decrease span for a high indication. Adjust the span screw to correct one-half the error.
6. Repeat steps 3 through 5 until the error is eliminated.
7. Adjust the remote set point pressure to 50 percent of the remote set point range.
8. Make sure the remote set point indicator is within ±1 percent of the mid-scale mark and, if so, proceed to step 10. If the set point indicator is not within ±1 percent but is within ±2 percent of the mid-scale mark then proceed with step 9. If the set point indicator is **not** within ±2 percent, proceed to the remote set point calibration in Section 5.
9. Loosen the zero adjustment locking screw and adjust the zero screw to correct for one-half the error. Tighten the locking screw.
10. Adjust the remote set point pressure to the lower and upper range limits and make sure the set point indicator is within ±1 percent.
11. Install the proportional band indicator cover and tighten the two screws.
12. If necessary, proceed to the process indicator zero-and-span calibration procedure in this section. Otherwise, proceed to the flapper alignment procedure in this section.

Flapper Alignment

Note
Perform the process indicator zero-and-span calibration procedure and, if necessary, the remote set point calibration procedure before the flapper alignment.

Flapper leveling screw numbers and adjustments are shown in figure 3-1.

Provide a means of applying supply pressure to the controller. Also, provide an accurate means of measuring output pressure.

Apply process differential pressure to the differential pressure unit. Refer to figures 2-1 and 2-2 for the differential pressure unit connections.

1. For a controller with manual set point, move the set point indicator to 50 percent of the scale range. For a controller with remote set point (suffix letter M), adjust the remote set point pressure until the set point indicator is at 50 percent of the scale range.
2. Apply differential pressure equal to 50 percent of the input range.

Note
If a pressure source is not available to pressure the input element (differential pressure unit) to 50 percent of range, an alternate method is to disconnect link 1 at the drive arm and tape the process indicator at 50 percent of the input range. Note the hole from which link 1 was removed for proper replacement.

This method should only be used if pressure is not available to drive the differential pressure unit to 50 percent.

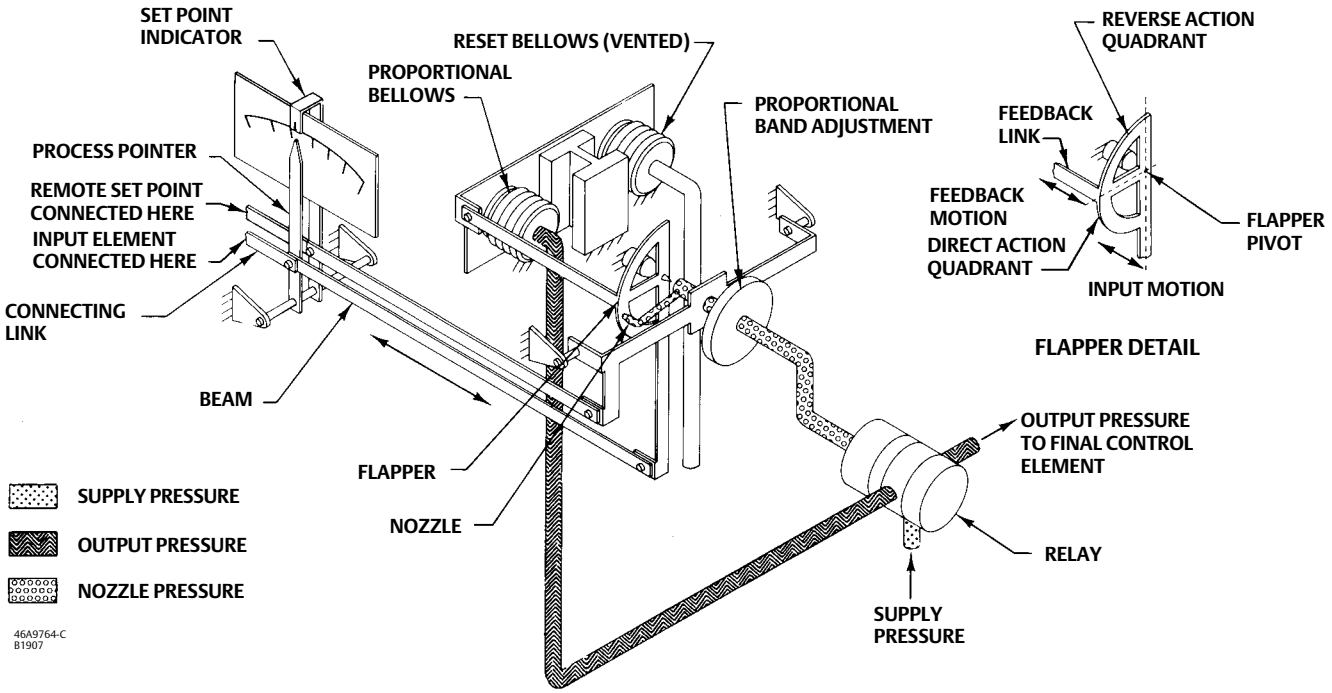
3. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36). Adjust the proportional band adjustment between DIRECT and REVERSE.
4. The controller output should be 0.62 ±0.007 bar (9 ±0.1 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 1.2 ±0.01 bar (18 ±0.2 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output. If not, adjust flapper leveling screw number 2.
5. Adjust the proportional adjustment to 20 percent DIRECT (direct acting).
6. The controller output should be 0.62 ±0.02 bar (9 ±0.25 psig) or 1.2 ±0.04 bar (18 ±0.5 psig). If not, adjust flapper leveling screw number 3.
7. Adjust the proportional band adjustment to 20 percent REVERSE (reverse acting).
8. The controller output should be 0.62 ±0.02 bar (9 ±0.25 psig) or 1.2 ±0.04 bar (18 ±0.5 psig). If not, adjust flapper leveling screw number 1.
9. Repeat steps 5 through 8 until the output of the controller remains in tolerance without further leveling screw adjustments.
10. If link 1 was disconnected, remove the tape and reconnect link 1 to the drive arm.
11. Set the proportional band adjustment to 400 percent in the desired controller action. Replace the proportional band indicator cover (key 36) and install the machine screws (key 6).

Principle of Operation for 4194HA Controllers

Overall Operation

Refer to the schematic diagram in figure 3-3.

Figure 3-3. Schematic for Fisher 4194HA Controller



The process differential pressure input element is connected to the process indicator and to the flapper by connecting links. As the process differential pressure increases (in a direct-acting controller), the flapper moves toward the nozzle, restricting flow through the nozzle and increasing nozzle pressure. When this occurs, relay action increases the output pressure (delivery) of the controller. Output pressure is fed back to the proportional bellows. The action of the proportional bellows counteracts the flapper movement that resulted from the process differential pressure change and backs the flapper away from the nozzle until equilibrium is reached.

The set point adjustment changes the distance between the nozzle and flapper as does a change in process differential pressure except that when the set point is changed, the nozzle moves with respect to the flapper.

The proportional band adjustment knob positions the nozzle on the flapper. Increasing (widening) the proportional band moves the nozzle to a position on the flapper where less input and more feedback motion occurs, which decreases the gain of the controller. Decreasing (narrowing) the proportional band moves the nozzle toward a position where more input and less feedback motion occurs, which increases the gain. The controller action is changed from DIRECT to REVERSE by turning the proportional band adjustment knob to position the nozzle on the flapper quadrant to a point where the direction of the flapper motion versus input motion is reversed (see flapper detail in figure 5-11). With the controller in the reverse-acting mode, an increase in process differential pressure causes a decrease in output pressure.

Remote Set Point Option (suffix letter M)

The capability to adjust the controller set point from a remote location is available with all 4194H controllers. This option is designated by the suffix letter M in the type number.

A control pressure is applied to the capsular element within the remote set point assembly. The expansion and contraction of the capsule moves the set point adjustment via a connecting linkage. Increasing the control pressure to the capsule increases the set point setting and decreasing the control pressure reduces the set point setting.

Auto/Manual Station Option (suffix letter E)

Controllers with the auto/manual option (designated by the suffix letter E in the type number) have piping on the output side of the relay as shown in figure 4-5. Supply pressure to the relay is also applied to the manual loader. The manual loader, functioning as a regulator, applies pressure to one side of the plastic tube and to the auto/manual switch. Output pressure from the relay registers on the other side of the plastic tube as well as in the auto/manual switch.

When the auto/manual switch is in the MANUAL position, the output of the manual loader is channeled through the auto/manual switch and becomes the output of the controller. When the auto/manual switch is in the AUTO position, the output of the relay is channeled through the switch to become the output of the controller.

Before the auto/manual switch is operated, the output of the relay must equal the output of the manual loader to avoid bumping the process. Adjusting the set point varies the pressure on the left-hand side of the plastic tube. Adjusting the manual loader knob varies the pressure on the right-hand side. When the pressures are equal, the metal ball is centered in the tube. Pressure imbalance forces the ball to one end of the tube where it forms a seal, blocking air flow through the tube.

Section 4

4194HB Proportional-Plus-Reset Controllers And 4194HC Proportional-Plus-Reset-Plus-Rate Controllers

Adjustments for 4194HB and HC Controllers

This section includes descriptions of adjustments and procedures for prestartup and startup.

Location of adjustments is shown in figure 3-1. To better understand the adjustments and overall operation of the controller, refer to the principle of operation and the schematic diagrams (figures 4-2 through 4-6). Unless otherwise noted, key numbers given in this section can be found in figure 6-1.

When placing the controller into operation use the following procedure for adjustment. Refer to figure 3-1 for locations of adjustments.

Manual Set Point Adjustment

To adjust the set point, open the controller cover and move the set point indicator until the indicator is at the desired value on the process differential pressure scale. Move the adjustment indicator to the right to increase the set point and to the left to decrease it. Adjusting the set point does not affect the proportional band setting.

If the controller is equipped with the optional external or internal set point adjustment, turn the adjustment knob clockwise to increase the process set point and counterclockwise to decrease the process set point.

Remote Set Point (suffix letter M) Adjustment

CAUTION

Do not manually move the set point indicator on a controller with remote set point. Doing so could damage the controller.

If the controller is equipped with the remote set point option, vary the remote set point pressure to change the set point. Increase the pressure to increase the set point and decrease the pressure to decrease the set point.

Proportional Band Adjustment (PB ADJ)

Locate the proportional band adjustment. Rotate the adjustment until the desired value is beneath the PB ADJ white indicator mark. Adjusting the proportional band has a minimal effect on the set point.

Changing Controller Action

Switch controller action from direct to reverse or vice-versa by simply loosening the screws on the proportional band indicator cover and pulling the cover outward so the proportional band adjustment can be rotated to the desired action (figure 5-2).

The white portion of the adjustment produces direct controller action. The black portion produces reverse controller action.

After changing the action, tighten the screws on the proportional band indicator cover.

Reset (suffix letter B) Adjustment

Locate the reset adjustment. Rotate the adjustment clockwise to decrease the minutes per repeat or counterclockwise to increase the minutes per repeat. Increasing the minutes per repeat provides a slower reset action.

Rate (suffix letter C) Adjustment

Locate the rate adjustment. Rotate the adjustment clockwise to decrease the minutes (faster rate action) or counterclockwise to increase the minutes (slower rate action).

Anti-Reset Windup (suffix letter F) Adjustment

If the arrow on the relief valve points toward the top of the controller case, as shown in figure 3-1, the valve opens when output pressure falls. If the arrow points in the opposite direction, the valve opens when output pressure rises. Turn the adjusting screw counterclockwise to increase differential relief pressure; clockwise to decrease it. Differential relief pressure is factory set at 0.3 bar (5 psi). Maximum differential relief pressure is 0.5 bar (7 psi). The minimum is 0.1 bar (2 psi).

Switching the Auto/Manual Station (suffix letter E)

Note

Switching the controller between automatic and manual mode without balancing can disturb the process and cause controller cycling.

Refer to figure 6-5 if the controller has the auto/manual station option.

Two balance methods are used to equalize the manual output pressure with the controller output pressure. To switch from automatic to manual mode, carefully adjust the loader knob until the metal ball inside the plastic tube moves into the switching zone. Then move the automatic/manual switch to MANUAL. Turn the loader knob clockwise to increase the controller output or counterclockwise to decrease it.

To switch from manual to automatic mode, slide the set point indicator to move the ball into the switching zone. Turn the switch to AUTO and move the set point indicator to control the output.

When the automatic/manual switch is in AUTO, adjusting the loader knob has no effect on the controller output. When the automatic/manual switch is in MANUAL, changing the set point adjustment has no effect on the controller output.

Prestartup Checks for 4194HB and HC Controllers

Refer to figure 3-1 for location of adjustments and to figure 6-1 for location of key numbers.

When performing the checks, open loop conditions must exist. An open loop exists when the controller output does not affect the input pressure or other control signal to the controller.

Note

If the controller has the auto/manual option (suffix letter E), be sure the controller is in the automatic mode before performing prestartup checks. If the controller has the external feedback option, connect the controller output connection to the external feedback connection (figure 2-2). Disconnect after completing the prestartup checks.

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge. Connect supply pressure to the supply pressure regulator and be sure it is delivering the proper supply pressure to the controller. Do not exceed the normal operating pressure in table 1-4.
2. For a controller with remote set point (suffix letter M), connect regulated pressure of 0.2 to 1.0 bar or 0.4 to 2.1 bar (3 to 15 psig or 6 to 30 psig) to the remote set point connection at the top of the controller case.
3. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Adjust the set point a minimum of 20 percent of input span above the process indicator.
5. Turn the reset adjustment to 0.01 minutes per repeat.
6. Turn the rate adjustment to OFF.
7. Adjust the proportional band knob to 5 percent DIRECT (direct action).
8. If necessary, connect a pressure source to the differential pressure unit and adjust the process indicator to the last scale mark on the left side of the scale. If the last scale mark is 0 psig, a pressure source is not required.
9. The controller output pressure should be 0 psig.
10. Rotate the proportional band to 5 percent REVERSE (reverse action).
11. The controller output should be within 0.14 bar (2 psig) of the supply pressure.
12. If the controller output is within tolerance, adjust the proportional band adjustment to 400 percent in the desired action, secure the proportional band indicator cover (key 36) with the two machine screws (key 6), and go to the startup procedure. If the controller output pressure is not within tolerance, go to the calibration procedure for 4194HB and HC controllers for recalibration.

Startup for 4194HB and HC Controllers

Calibrate the controller prior to this procedure.

Note

When performing the startup procedure, keep in mind the initial settings are guidelines. They will vary depending on the actual process being controlled.

1. Be sure the supply pressure regulator is delivering the proper supply pressure to the controller.
2. Move the set point adjustment to the desired set point.
3. Set the reset adjustment to **0.05** minutes per repeat for **fast** processes. Set it to **0.5** minutes per repeat for **slow** processes. For controllers with rate, set the rate adjustment to OFF.
4. Set the proportional band adjustment to 100 percent for fast processes. For slow processes, calculate the

proportional band percentage from the equation below:

$$\text{Proportional Band Adjustment} = \frac{200 \times \text{Allowable Overshoot}}{\text{Pressure Span}}$$

For example:

$$\frac{200 \times 2 \text{ Psig}}{30 \text{ Psig}} \cong 13\%$$

5. If the controller is used with a control valve, return the control valve to service by slowly opening the upstream and downstream manual control valves in the pipeline. Close the manual bypass valve, if one is used.
6. Tune the various controller actions.
   - Tuning proportional action: Create a load upset by momentarily changing the set point. Check for system cycling. If the system does not cycle, lower the proportional band setting (thus raising the gain) and disturb the system again by changing the set point. Continue this procedure until the system cycles. At this point, double the proportional band setting (proportional band setting X 2).
   - Tuning reset action: Disturb the system. If the system does not cycle then speed up the reset by changing the setting to a lower value (faster reset) and disturb the system again. Continue this procedure until the system cycles. When the system cycles, multiply the reset time setting by a factor of three (reset time 3) and slow down the reset by changing the setting to the higher value. The reset is now tuned.
   - Tuning rate action: For a controller with rate (4194HC controllers), adjust the rate toward the lowest setting until cycling occurs. When the system cycles, multiply the rate value by a factor of three (reset time X 3) and slow down the rate by changing the setting to the higher value. The rate is now tuned.
7. Check the stability of the recommended proportional band setting by introducing a disturbance and monitoring the process.
8. Once stable control is attained, the process indicator and set point adjustment indicator should be in line. If they are aligned, return the set point to the desired value. If they are not, readjust the set point to the desired control point on the process scale and proceed with step 9.
9. If the process indicator is within ±5 percent of the set point indicator, turn the link 3 adjustment (see figure 5-3 for location) until the process indicator aligns with the set point indicator. Turn the link 3 adjustment screw clockwise to increase the process indication or counterclockwise to decrease it. If the process indicator is misaligned with the set point adjustment by more than ±5 percent of the scale span, perform the calibration procedure for 4194HB and HC controllers.

Calibration for 4194HB and HC Controllers

⚠ WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure, do not exceed the operating limits given in this manual.

General Calibration Instructions

Note
If the controller has the auto/manual option, be sure the controller is in the automatic mode before performing calibration.

If the prestartup checks or startup reveal faulty controller operation, perform the calibration described in this section. These instructions are valid for either shop or field calibration, if open process loop conditions exist.

Unless otherwise noted, key numbers refer to figure 6-1.

Process Indicator Zero-and-Span Calibration

Provide a regulated process differential pressure to the differential pressure unit. Also, plug the controller output connection and provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-4.

Refer to figure 3-1 for location of adjustments.

Note

Any adjustment of the process indicator span adjustment screw requires readjustment of the process indicator zero adjustment screw.

1. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band adjustment between DIRECT and REVERSE.
3. Adjust the process differential pressure until the input to the differential pressure unit is equal to the lowest limit of the scale range.
4. If necessary, adjust the process indicator to the lowest limit of the process scale by loosening the zero adjustment locking screw and turning the zero adjustment screw.
5. Adjust the process differential pressure until the input to the differential pressure unit is equal to the highest limit of the scale range.
6. Note whether the process indicator is above or below the upper limit of the process scale.
7. Adjust the process indicator span adjustment screw as follows: Clockwise to increase the span for a low indication; counterclockwise to decrease the span for a high indication. Adjust the span adjustment screw to correct for approximately one-half the error.
8. Repeat steps 3 through 7 until the error is eliminated.
9. Adjust the process differential pressure until the input to the differential pressure unit is equal to 50 percent of the process scale range. The process indicator should point to the 50 percent process scale mark within ±2 percent of span.
   - If the error is greater than ±2 percent, perform the appropriate maintenance calibration procedure in the Maintenance section.
   - If the error is less than ±2 percent but more than ±1 percent, proceed with step 10.
10. Adjust the process indicator to within ±1 percent of the 50 percent scale mark by loosening the zero adjustment locking screw and turning the zero adjustment screw. This distributes the error over the entire scale range and brings all points within ±1 percent of the process input span.
11. Adjust the process differential pressure to 0 percent of the scale range.
12. The process indicator should indicate a zero scale reading, ±1 percent of the scale span.
13. Adjust the process differential pressure to 100 percent of the scale range.
14. The process indicator should point to the full scale reading, ±1 percent of the process scale span.

15. If the error is greater than ±1 percent, repeat steps 3 through 14.
16. Perform the flapper alignment procedure.

Remote Set Point (suffix letter M) Zero-and-Span Calibration

Refer to figure 3-1 for location of adjustments. Refer to figures 6-1 and 6-3 for key number locations.

Note

Any adjustment of the remote set point span adjustment screw will require readjustment of the set point zero adjustment screw. See figure 3-1.

Provide a regulated process differential pressure to the differential pressure unit. Also, plug the controller output connection and provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-4.

1. Remove two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band adjustment between DIRECT and REVERSE.
3. Apply remote set point pressure equal to the low limit of the set point input range. Note the position of the set point indicator. Loosen the set point zero adjustment locking screw and adjust the zero adjustment screw (figure 5-6) until the set point indicator aligns with the lowest scale limit.

   Properly align the set point indicator with the low scale limit. Tighten the zero adjustment locking screw.
4. Adjust the remote set point pressure to the upper limit of the input span. Note whether the indication is above or below the upper limit of the process scale.
5. Adjust the span screw (figure 3-1) as follows: Clockwise to increase span for a low indication; counterclockwise to decrease span for a high indication. Adjust the span screw to correct one-half the error.
6. Repeat steps 3 through 5 until the error is eliminated.
7. Adjust the remote set point pressure to 50 percent of the remote set point range.
8. Make sure the remote set point indicator is within ±2 percent of the mid-scale mark, then proceed with step 9. If the set point indicator is not within ±2 percent, proceed to the Remote Set Point Maintenance Calibration procedure in Section 5.
9. Loosen the zero adjustment locking screw. Adjust the zero screw to correct for half the error.
10. Adjust the remote set point pressure to the lower and upper range limits. Make sure the set point indicator is within ±1 percent.
11. Install the proportional band indicator cover (key 36) and tighten two screws (key 6).
12. If necessary, proceed to the process indicator zero-and-span calibration procedure in this section. Otherwise, proceed to the flapper alignment procedure in this section.

Flapper Alignment

Note

Perform the process indicator zero-and-span calibration procedure and, if necessary, the remote set point calibration procedure before the flapper alignment.

If the controller has the external feedback option, connect the external feedback connection to the controller output connection.

Flapper leveling screw numbers and adjustments are shown in figure 3-1.

Provide a regulated process differential pressure to the differential pressure unit. Also, plug the controller output connection and provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-4.

Note

4194HB and HC controllers with the anti-reset windup option (suffix letter F) are supplied with two O-rings (key 52, figure 6-1/CONTROLLER COMMON PARTS), valve cover (key 51, figure 6-1/VIEW E, 4194HB controllers or VIEW E, 4194HC controllers), and two machine screws (key 53, figure 6-1/VIEW E, 4194HB controllers or VIEW E, 4194HC controllers). Use these parts in the next step.

1. For 4194HB and HC controllers with the anti-reset windup option (suffix letter F), remove the differential relief valve (key 55, figure 6-1/VIEW E, 4194HB controllers, Option F or VIEW E, 4194HC controllers, Option F). Install the two O-rings (key 52) and valve cover (key 51) provided with the controller. Secure the valve cover over the two O-rings with the two machine screws (key 53) also provided.
2. For a controller with manual set point, move the set point indicator to 50 percent of the scale range. For a controller with remote set point (suffix letter M), adjust the remote set point pressure until the set point indicator is at 50 percent of the scale range.
3. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Adjust the reset adjustment to 0.01 minute per repeat.
5. If the controller has rate (4194HC controllers), turn the rate adjustment to OFF.
6. If the controller has the external feedback option (available with a 4194HB controller only), shut off the supply pressure, connect the controller output to the external feedback connection, and turn on the supply pressure. See figure 2-2 for the location of the output and external feedback connections.
7. Adjust the process differential pressure to 50 percent of the input range. If pressure is not available to pressure the differential pressure unit to 50 percent of range, an alternate method is to disconnect link 1 at the drive arm and tape the process indicator at 50 percent of the process differential pressure input range.

Note

In steps 8 through 12, the controller output will not stabilize because of the high controller gain. The controller output gauge is adequate to check the output pressure during this procedure.

8. Set the proportional band between DIRECT and REVERSE.
9. Adjust flapper leveling screw number 2 until the controller output is relatively stable at any value within the output range.
10. Adjust the proportional band to 20 percent direct acting. Adjust flapper leveling screw number 3 until the controller output is relatively stable at any value within the output range.
11. Adjust the proportional band to 20 percent reverse acting. Adjust flapper leveling screw number 1 until the controller output is relatively stable at any value within the output range.
12. Repeat steps 8 through 11 until the controller output remains relatively stable with no adjustments of the flapper leveling screws.

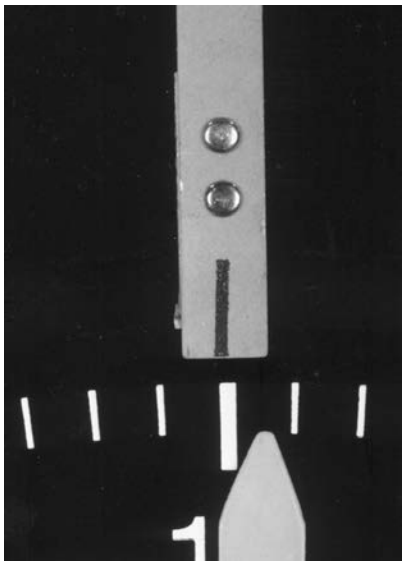
Note

Steps 13 through 19 check the flapper alignment.

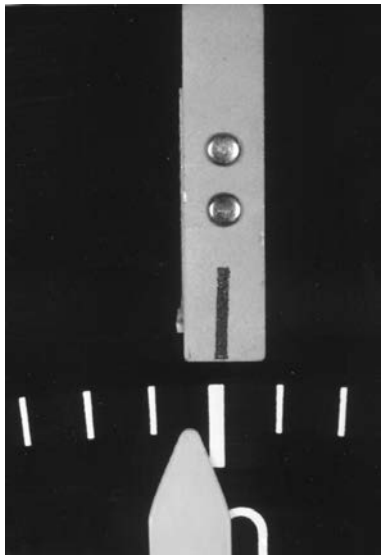
13. Adjust the proportional band to 100 percent direct action.
14. Apply differential pressure to the differential pressure unit or, if link 1 was disconnected, remove the tape from the process indicator and move the indicator until it aligns with the right-hand edge of the set point indicator (as shown in figure 4-1).

    Controller output should be within 0.14 bar (2 psig) of the supply pressure.
15. Apply differential pressure to the differential pressure unit or, if disconnected, move the process indicator to the left-hand edge of the set point indicator (as shown in figure 4-1).

Figure 4-1. Alignment of the Process Pointer with the Set Point Adjustment



RIGHT-HAND EDGE



LEFT-HAND EDGE

Controller output pressure should go to 0 psig.

16. Adjust the proportional band to 100 percent reverse action.
17. Pressure the differential pressure unit or, if disconnected, move the process indicator to align with the right-hand edge of the set point indicator. The controller output should be 0 psig.
18. Pressure the differential pressure unit or, if disconnected, position the process indicator to align with the left-hand edge of the set point indicator. The controller output should be within 0.14 bar (2 psig) of supply pressure.
19. If the controller does not perform as indicated in steps 13 through 18, the flapper is not correctly aligned. This may occur because the output was not sufficiently stabilized in steps 8 through 12. Repeat steps 7 through 18.
20. Set the proportional band to 400 percent in the desired controller action. Replace the proportional band indicator cover (key 36) and install the two machine screws (key 6). If link 1 was disconnected, reconnect link 1 to the drive arm using the same hole connections.
21. If the controller has the external feedback option, disconnect the outside tubing which connects the external feedback connection to the output connection.
22. For 4194HB and HC controllers with the anti-reset windup option (suffix letter F), remove the two machine screws (key 53), valve cover (key 51), and two O-rings (key 52) installed in step 1 of this procedure. Install the differential relief valve (key 55).

Anti-Reset Windup Valve (suffix letter F) Calibration

Calibration for the anti-reset windup valve to relieve on rising controller output pressure:

1. Plug the controller output connection or connect it to a pressure gauge if desired (open-loop conditions must exist).
2. Set the reset adjustment to 0.01 minute per repeat (wide open) and the rate adjustment (4194HC controllers only) to the OFF position.
3. For a controller with manual set point, move the set point indicator to 50 percent of the scale range. For a controller with remote set point, adjust the remote set point pressure until the set point indicator is at 50 percent of the scale range.
4. Adjust the proportional band to 100 percent in either the DIRECT or REVERSE action depending on the application requirements.
5. Refer to figure 3-1 for the location of the anti-reset windup valve. For the anti-reset windup valve to relieve on rising controller output pressure, install the valve so the arrow on the valve points down. If you must change the direction of the arrow, loosen the two mounting screws, pull the valve out, and reinstall with the arrow direction reversed. Tighten the two mounting screws.
6. Turn on the supply pressure to the recommended value shown in table 1-4.

Note

Because of the high controller gain with the reset adjustment at 0.01 minute per repeat, the controller output will not balance perfectly in the following step. If the controller output is stable for approximately 5 seconds, it is adequately balanced.

7. Increase the process differential pressure to the differential pressure unit until the controller output pressure is balanced at 2.0 bar (6 psig) [for a 0.2 to 1.0 bar (3 to 15 psig) output range] or 0.8 bar (12 psig) [for a 2.0 to 4.0 bar (6 to 30 psig) output range].
8. Turn the reset adjustment to the CLOSED (4194HB controllers) or OFF (4194HC controllers) position.
9. Increase the controller output pressure in small steps [approximately 0.04 bar (0.5 psig]) by changing the input to the differential pressure unit or by changing the controller set point. After each change in differential pressure or set point, the controller output pressure should quickly change and then stabilize at the new value.
10. Continue to change the controller output pressure in 0.04 bar (0.5 psi) steps and check the output pressure after each step to make sure it stabilizes. At some point, the controller output will start to ramp upward to supply pressure with no further change to the controller input or set point. Record the controller output pressure where this ramping action begins because this is the point at which the anti-reset windup valve has relieved.
11. To obtain the anti-reset windup valve differential setting, calculate the difference between the original controller output pressure in step 7 and the controller output pressure recorded in step 10.
12. If the differential pressure calculated in step 11 is incorrect for the application, adjust the differential by turning the anti-reset windup valve adjustment screw (figure 3-1). Decrease the differential pressure by turning the screw clockwise. Increase the differential pressure by turning the screw counterclockwise. The anti-reset windup valve is set at the factory at approximately 0.4 bar (5 psi) differential pressure.
13. Repeat steps 7 through 12 until the required differential pressure is obtained.

Calibration for the anti-reset windup valve to relieve on falling controller output pressure:

1. Plug the controller output connection or connect it to a pressure gauge if desired (open-loop conditions must exist).
2. Set the reset adjustment to 0.01 minute per repeat (wide open) and the rate adjustment (4194HC controllers only) to the OFF position.

3. For a controller with manual set point, move the set point indicator to 50 percent of the scale range. For a controller with remote set point, adjust the remote set point pressure until the set point indicator is at 50 percent of the scale range.
4. Adjust the proportional band to 100 percent in either the DIRECT or REVERSE action depending on the application requirements.
5. Refer to figure 3-1 for the location of the anti-reset windup valve. For the anti-reset windup valve to relieve on falling controller output pressure, install the valve so the arrow on the valve points up. If you must change the direction of the arrow, loosen the two mounting screws, pull the valve out, and reinstall with the arrow direction reversed. Tighten the two mounting screws.
6. Turn on the supply pressure to the recommended value shown in table 1-4.

Note

Because of the high controller gain with the reset adjustment at 0.01 minute per repeat, the controller output will not balance perfectly in the following step. If the controller output is stable for approximately 5 seconds, it is adequately balanced.

7. Increase the differential pressure input to the differential pressure unit until the controller output pressure balances at 12 psig (for a 3 to 15 psig output range) or 24 psig (for a 6 to 30 psig output range).
8. Turn the reset adjustment to the CLOSED (4194HB controllers) or OFF (4194HC controllers) position.
9. Decrease the controller output pressure in small steps (approximately 0.5 psig) by changing the input to the differential pressure unit or by changing the controller set point. After each change in differential pressure unit input or set point, the controller output pressure should quickly change then stabilize at the new value.
10. Continue to change the controller output pressure in 0.04 bar (0.5 psi) steps and check the output pressure after each step to make sure it stabilizes. At some point, the controller output will start to ramp downward to 0 psig with no further change to the controller input or set point. Record the controller output pressure where this ramping action begins because this is the point at which the anti-reset windup valve has relieved.
11. To obtain the anti-reset windup valve differential setting, calculate the difference between the original controller output pressure in step 7 and the controller output pressure recorded in step 10.
12. If the differential pressure calculated in step 11 is incorrect for the application, adjust the differential by turning the anti-reset windup valve adjustment screw (figure 3-1). Decrease the differential pressure by turning the screw clockwise. Increase the differential pressure by turning the screw counterclockwise. The anti-reset windup valve is factory set at approximately 0.14 bar (5 psi) differential pressure.
13. Repeat steps 7 through 12 until the required differential pressure is obtained.

Principle of Operation for 4194HB and HC Controllers

Overall Operation

Refer to the schematic diagrams in figures 4-2 and 4-3 for the 4194HB controllers and the 4194HC controllers.

The differential pressure unit (input element) connects to the process indicator and to the flapper by connecting links. As the process differential pressure increases (in a direct-acting controller), the flapper moves toward the nozzle, restricting flow through the nozzle and increasing nozzle pressure. When this occurs, relay action increases the output pressure (delivery) of the controller.

Output pressure is fed back to the proportional bellows and to the reset bellows. The action of the proportional bellows quickly counteracts the flapper movement resulting from the process differential pressure change and backs the flapper away from the nozzle.

Pressure in the reset bellows opposes the action of the proportional bellows and slowly moves the flapper closer to the nozzle. The result of this interaction is that when the process differential pressure changes, proportional action temporarily reduces the gain of the controller for improved stability. The process differential pressure then slowly returns to set point, as pressure in both bellows equalizes via the reset action.

The set point adjustment changes the distance between the nozzle and flapper as does a change in process differential pressure, except that when the set point changes, the nozzle moves with respect to the flapper.

The proportional band adjustment knob positions the nozzle on the flapper. Increasing (widening) the proportional band moves the nozzle to a position on the flapper where less input and more feedback motion occurs, which decreases the gain of the controller. Decreasing (narrowing) the proportional band moves the nozzle toward a position where more input and less feedback motion occurs, which increases the gain.

Figure 4-2. Schematic of Operation for Fisher 4194HB Controller

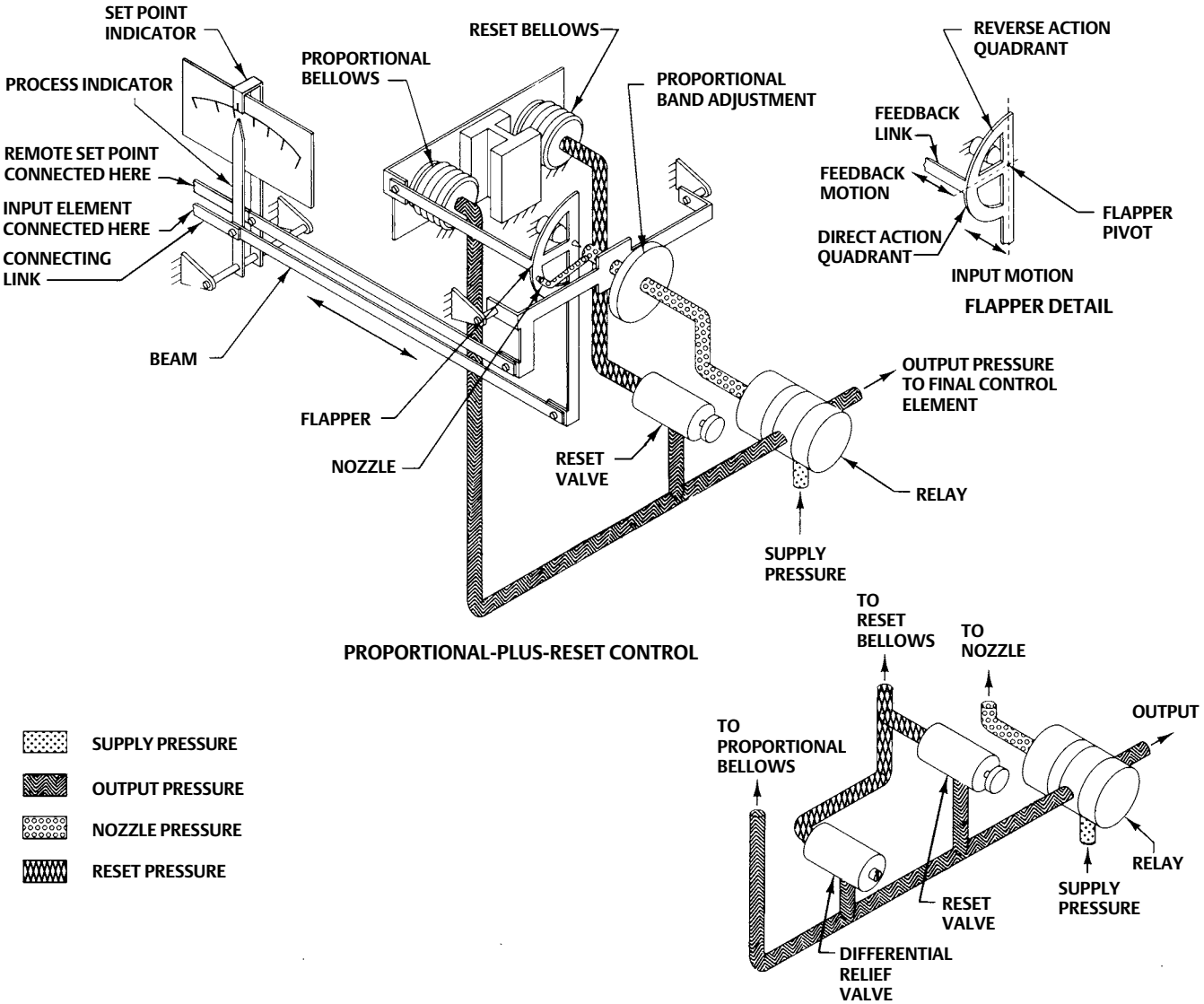
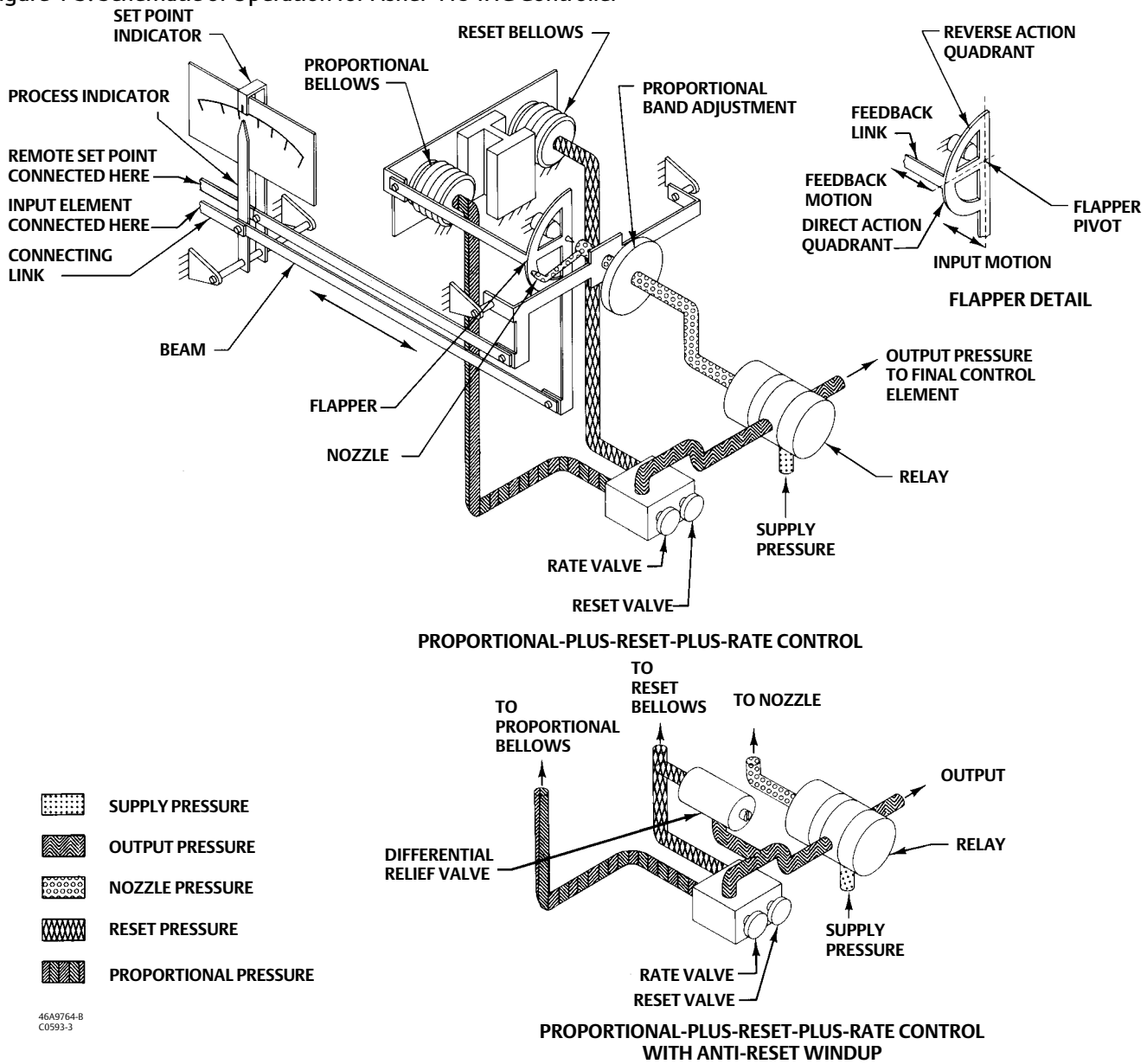


Figure 4-3. Schematic of Operation for Fisher 4194HC Controller



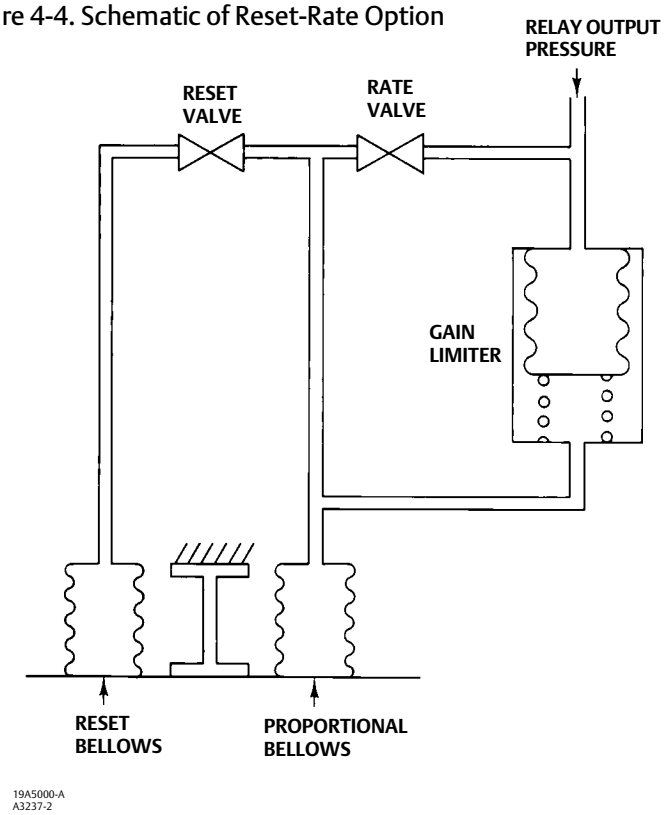
The controller action is changed from DIRECT to REVERSE by turning the proportional band adjustment knob to position the nozzle on the flapper quadrant to a point where the direction of the flapper motion versus input motion is reversed (see flapper detail in figure 4-2). With the controller in the reverse-acting mode, an increase in process differential pressure causes a decrease in output pressure.

A 4194HC controller also has a rate valve (figure 4-4), which is an adjustable restriction that momentarily increases the controller gain to accelerate the corrective action for slow pressure systems. A proportional-plus-reset-plus-rate controller responds to a change in process differential pressure as follows:

- First, the rate action delays the proportional action just long enough to allow the controller to respond to the change quickly with high gain but not long enough for the high gain to cause instability.

- Then, the low gain provided by the proportional action keeps the system stable. Finally, reset action slowly increases the gain and returns the process differential pressure toward the set point.

Figure 4-4. Schematic of Reset-Rate Option



Anti-Reset Windup Option (suffix letter F)

Anti-reset windup is available for all 4194HB and HC controllers and is designated by the letter F in the type number. The differential relief valve operates when the difference between the proportional bellows pressure and the reset bellows pressure reaches a predetermined value. Anti-reset windup reduces overshoot of the process differential pressure that can result from a large or prolonged deviation from set point such as at process startup.

Remote Set Point Option (suffix letter M)

The capability to adjust the controller set point from a remote location is available for all 4194H controllers. With this option, a control pressure is applied to the capsular element within the remote set point assembly. The expansion and contraction of the capsule moves the set point adjustment via connecting linkage. Increasing the control pressure to the capsule increases the set point setting and decreasing the control pressure reduces the set point setting.

This option is designated by the suffix letter M in the type number.

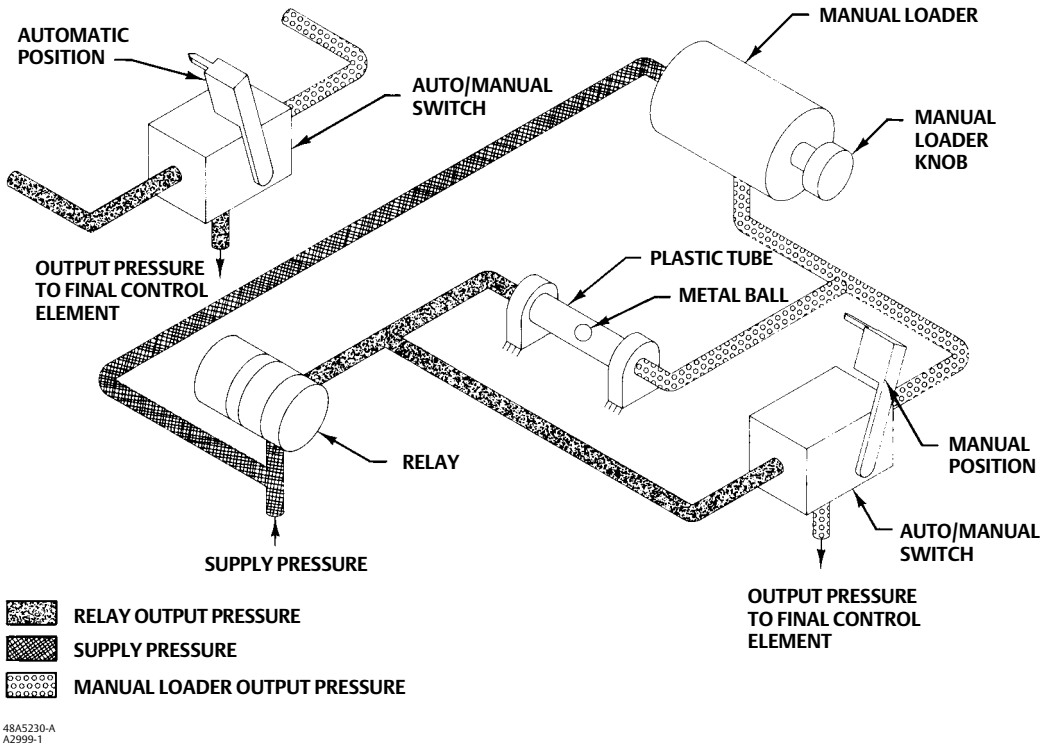
Auto/Manual Station Option (suffix letter E)

A controller with the auto/manual option (suffix letter E) has piping on the output side of the relay as shown in figure 4-5. Supply pressure to the relay is also applied to the manual loader. The manual loader, functioning as a regulator,

applies pressure to one side of the plastic tube and to the auto/manual switch. Output pressure from the relay registers on the other side of the plastic tube as well as in the auto/manual switch.

When the auto/manual switch is in the MANUAL position, the output of the manual loader is channeled through the auto/manual switch and becomes the output of the controller. When the auto/manual switch is in the AUTO position, the output of the relay is channeled through the switch to become the output of the controller.

Figure 4-5. Schematic of Auto/Manual Option



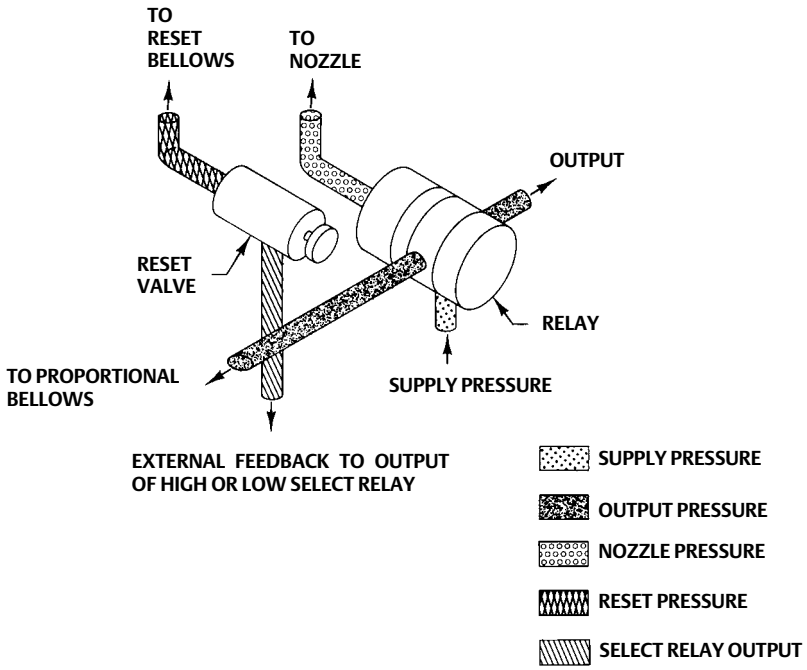
Before the auto/manual switch is operated, the output of the relay must equal the output of the manual loader to avoid bumping the process. Adjusting the set point varies the pressure on the left-hand side of the plastic tube. Adjusting the manual loader knob varies the pressure on the right-hand side of the plastic tube. When the pressures are equal, the metal ball is centered in the tube and it is held in place by a small magnet. Pressure imbalance forces the ball to one end of the tube where it forms a seal, blocking air flow through the tube.

External Feedback Option

External feedback is available for all 4194HB controllers. Controllers with this option have an external connection on the bottom of the controller case (figure 2-2). This connection breaks the positive feedback (reset) loop inside the controller and brings it outside (figure 4-6).

The connection allows the positive feedback loops of two controllers (primary and secondary) to be tied together when the controllers are used in an override application. When connected, the secondary controller reset pressure tracks the primary controller output pressure, minimizing reset windup in the secondary controller.

Figure 4-6. Schematic of External Feedback Option



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Section 5

Maintenance

Inspection and Maintenance

Controller parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of service conditions. When inspection or repairs are require, disassemble only those parts necessary to accomplish the job. Figure 5-1 is a maintenance guide which summarizes the information available in the maintenance procedures.

⚠ WARNING

The following maintenance procedures require taking the controller out of service. To avoid personal injury and property damage caused by uncontrolled process pressure, observe the following before performing any maintenance procedures:

- **Always wear protective clothing, gloves, and eyewear when performing any maintenance operations to avoid personal injury.**
- **Provide some temporary means of control for the process before taking the controller out of service.**
- **Shut off the supply pressure to the controller.**
- **Personal injury or property damage may result from fire or explosion if natural gas is used as the supply medium and preventive measures are not taken. Preventive measures may include but are not limited to, one or more of the following: Remote venting of the unit, re-evaluating the hazardous area classification, ensuring adequate ventilation, and the removal of any ignition sources. For information on remote venting of this controller, refer to page 11.**
- **Disconnect any operating lines providing supply air pressure, a process input signal, or other pressure source to the controller.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect again process media.**

Note

Unless otherwise noted, key numbers refer to figure 6-1. Figure 3-1 shows the location of adjustments and major components. For maintenance on the indicator assembly, refer to figure 6-4.

Select the appropriate maintenance procedure and perform the numbered steps. Shut off the supply pressure and process pressure before beginning maintenance.

The maintenance procedures section describes part replacement common to 4194HA, HB, and HC controllers. Other portions of the maintenance procedures describe replacing the differential pressure unit, making process zero-and-span and flapper alignments, and other calibration and maintenance procedures.

When maintenance procedures, including flapper alignment, have been completed, refer to the appropriate prestartup procedure.

Troubleshooting

As an aid to troubleshooting, table 5-1 lists some common operating faults, their probable cause, and suggested procedures for correcting the fault.

Figure 5-1. Maintenance Guide

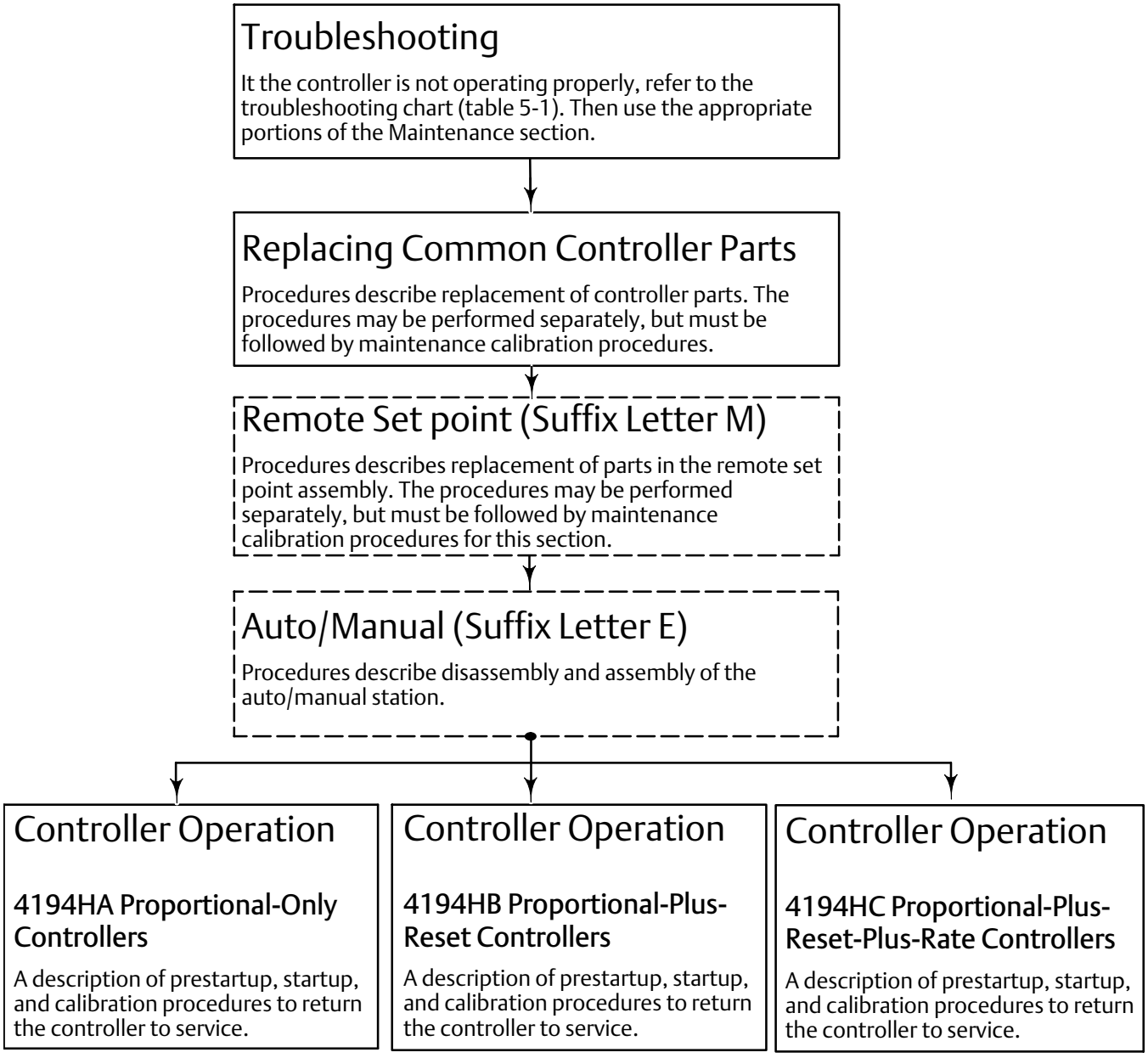
Troubleshooting
It the controller is not operating properly, refer to the troubleshooting chart (table 5-1). Then use the appropriate portions of the Maintenance section.
Replacing Common Controller Parts
Procedures describe replacement of controller parts. The procedures may be performed separately, but must be followed by maintenance calibration procedures.
Remote Set point (Suffix Letter M)
Procedures describes replacement of parts in the remote set point assembly. The procedures may be performed separately, but must be followed by maintenance calibration procedures for this section.
Auto/Manual (Suffix Letter E)
Procedures describe disassembly and assembly of the auto/manual station.
Controller Operation
4194HA Proportional-Only Controllers
A description of prestartup, startup, and calibration procedures to return the controller to service.
Controller Operation
4194HB Proportional-Plus-Reset Controllers
A description of prestartup, startup, and calibration procedures to return the controller to service.
Controller Operation
4194HC Proportional-Plus-Reset-Plus-Rate Controllers
A description of prestartup, startup, and calibration procedures to return the controller to service.

Table 5-1. Troubleshooting Chart

Fault	Possible Cause	Check	Correction
1. Process wanders or cycles about set point.	1.1 Proportional band and reset settings.	1.1 Refer to the Start-up section for controller settings.	1.1 If stable control cannot be attained, and all other elements of the loop are functionally correct, examine other possible causes related to the controller.
	1.2 Supply pressure varying.	1.2 Monitor the supply pressure with an external gauge. Ensure that it is set correctly and does not fluctuate. Note the number of instruments being supplied by the regulator.	1.2 Correct as necessary. One regulator per instrument is recommended.
	1.3 Process pointer rubbing on cover or scale.	1.3 Note if the pointer is bent.	1.3 Bend pointer to provide clearance.
	1.4 Failure of differential pressure unit.	1.4 Inspect the differential pressure unit. Using a soap solution, check for leaks. Refer to the differential pressure unit instruction manual.	1.4 Replace the differential unit as necessary.
	1.5 Linkage failure.	1.5 Check for links bent or not connected properly, or pivots broken.	1.5 Replace or repair as necessary.
	1.6 Relay malfunction.	1.6 By changing the process differential pressure in the sensor and observing the output, verify that the output will move at about the same speed in both directions.	1.6 If the output moves fast in one direction and sluggishly in the other, replace the relay.
	1.7 Differential relief valve set too low.	1.7 The minimum relief valve setting is dependent on the loop dynamics and the controller settings. If, under normal load changes, the relief valve opens, instability can occur. Check by observing the controller reaction to a set point or load change under closed loop conditions.	1.7 If the differential relief valve appears to be set too low, refer to the section of this instruction manual that covers the anti-reset windup option.
2. Controlling off set point as reflected by process and set point indicators. Note: Some offset is inherent with proportional-only controllers (4194HA controllers). The amount of offset is a function of the proportional band setting.	2.1 Supply pressure not set correctly.	2.1 Check with an external source.	2.1 Reset the supply pressure if necessary. If the condition occurs again, the regulator should be rebuilt or replaced.
	2.2 Flapper not aligned.	2.2 Refer to the Flapper alignment procedure.	2.2 Align the flapper as necessary.
	2.3 Linkage not aligned correctly.	2.3 Refer to the Maintenance Calibration section.	2.3 Adjust as necessary.
	2.4 Leak in differential pressure unit or tubing.	2.4 Using soap solution, check for leaks. Refer to the differential pressure unit instruction manual.	2.4 Repair or replace parts as necessary.
	2.5 Indicators out of calibration.	2.5 Refer to the process (and remote set if applicable) zero and span adjustment procedure.	2.5 Adjust as necessary.
	2.6 Linkage not connected correctly.	2.6 Inspect for loose screws, links or pivots.	2.6 Repair or replace parts as necessary.
	2.7 Leak in feedback system.	2.7 Open the reset valve to .01 minute/ repeat. Adjust output pressure to 1.4 bar (20 psig). Using soap solution, check for leaks in the proportional and reset bellows in the tubing that connects these bellows.	2.7 Repair as necessary. 2.8 Replace the reset valve.
	2.8 Reset valve leaks.	2.8 Adjust output to 1.0 bar (15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 2.0 bar (30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output. Close the reset valve. If the controller output varies as reset valve is closed and no leaks were found in the rest of the feedback system (Step 2.7), the reset valve is leaking.	2.9 Repair or replace parts as necessary.
	2.9 Leak in remote set point system.	2.9 Adjust remote set point pressure to 1.0 bar (15 psig). Using soap solution, check for leaks in the remote set point and tubing assembly.	

-Continued-

Table 5-1. Troubleshooting Chart (Continued)

Fault	Possible Cause	Check	Correction
3. Controlling off set point but not reflected by process and set point indicators.	3.1 Out of calibration.	3.1 Refer to the calibration and flapper alignment procedures.	3.1 Adjust as necessary.
4. No reset action (4194HB and 4194HC controllers).	4.1 Reset valve is plugged.	4.1 Turn the reset valve through its range several times to remove any restrictions.	4.1 If reset action returns, no further action is necessary. If not, replace the reset valve (4194HB) or rate/reset valve (4194HC).
	4.2 Reset pressure leak.	4.2 Adjust the output to 1.0 bar (15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 2.0 bar (30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output. Close the reset valve. If the output varies and no leaks were found in the rest of the feedback system (see Step 2.7), the reset valve is leaking.	4.2 Replace the reset valve if necessary.
	4.3 Tubing leak.	4.3 With reset valve positioned at 0.01 MIN/repeat put 1.0 bar (15 psig) to the output port. Using soap solution, check for leaks in the reset bellows and attached tubing assembly.	4.3 Repair or replace parts as necessary.
5. Abnormal control point shift when proportional band is changed.	5.1 Flapper is dirty or pitted.	5.1 Inspect the flapper.	5.1 Clean, or replace flapper as necessary.
	5.2 Flapper is out of alignment.	5.2 Refer to flapper alignment procedures.	5.2 Align flapper as necessary.
6. Controller will not attain full output range.	6.1 Output pressure gauge not functioning.	6.1 Measure the output with an external pressure gauge.	6.1 Replace the gauge if it is defective.
	6.2 Supply pressure not correct.	6.2 Check with an external source.	6.2 Repair or replace the supply pressure regulator, if necessary. Replace the supply pressure gauge if necessary.
	6.3 Proportional band setting too wide (4194HA controllers only).	6.3 Adjust proportional band setting to 10. Manually cap the nozzle. Output should increase.	6.3 Use a narrower proportional band setting.
	6.4 Differential pressure unit or linkage failure.	6.4 Inspect the linkages for misalignment, loose screws, and damaged links or pivots. Using soap solution, check for leaks. Refer to the differential pressure unit instruction manual.	6.4 Repair as necessary.
	6.5 Leak in nozzle pressure tubing.	6.5 Using soap solution, check for leaks in the nozzle tubing assembly.	6.5 Replace faulty parts as necessary. Clean out the relay primary orifice with the cleanout wire attached to the relay to ensure the orifice is not clogged.
	6.6 Relay malfunction	6.6 Manually push the flapper away from the nozzle. The output pressure should be zero. Cap the nozzle. The output should increase rapidly to within 0.03 bar (0.5 psig) of the supply pressure.	6.6 If the output does not change as described, remove the relay. Replace O-rings, if necessary. Replace relay, if necessary.
7. Controller remains at full output.	7.1 Supply pressure too high.	7.1 Check with an external pressure gauge.	7.1 Supply pressure regulator or gauge may have to be replaced.
	7.2 Output gauge not functioning.	7.2 Vary supply pressure to see if output gauge responds.	7.2 If output gauge does not respond, replace it.
	7.3 Differential pressure unit or linkage failure.	7.3 Vary the process differential pressure and observe the flapper. Inspect the linkages for damage. Refer to the differential pressure unit instruction manual.	7.3 Repair or replace parts as necessary.
	7.4 Mechanical alignment.	7.4 Move the set point and verify that the nozzle is uncapped by the flapper. If not, inspect linkages for damage.	7.4 Repair or replace parts as necessary.

-Continued-

Table 5-1. Troubleshooting Chart (Continued)

Fault	Possible Cause	Check	Correction
7. Controller remains at full output. (continued)	7.5 Relay failure or restriction in nozzle passage.	7.5 Manually move flapper 1.6 mm (1/16-inch) from the nozzle.	7.5 If the output pressure remains at the supply pressure, remove the controller case and cover assembly and test again with the relay nozzle tubing nut loose. If the output is 0 bar (0 psig), clean or replace the nozzle assembly. If the output remains at supply pressure, replace the relay.
	7.6 Flapper misaligned.	7.6 Manually push the flapper away from the nozzle. Controller output should go to 0 psig.	7.6 Perform the flapper alignment procedure.
8. Controller remains at zero output.	8.1 Gauge not functioning.	8.1 Verify that the supply pressure is at its correct value and that the controller output is zero.	8.1 Replace gauges as necessary.
	8.2 Differential pressure unit or linkage failure.	8.2 Vary the process differential pressure and observe the flapper. Inspect the sensor and linkages for damage. Refer to the differential pressure unit instruction manual.	8.2 Repair or replace parts as necessary.
	8.3 Mechanical alignment.	8.3 Move the set point and verify that the nozzle can be capped by the flapper. If not, inspect linkages and flexures for damage.	8.3 Repair or replace parts as necessary.
	8.4 Relay malfunction.	8.4 With the supply pressure on, check for a low flow of air at the nozzle output. When capped, the output pressure should build rapidly. The relay should open and pass a large flow of air through the “OUTPUT” nipple.	8.4 Press the cleanout wire on the relay. If the problem persists, replace the relay.
	8.5 Nozzle pressure leak.	8.5 Check for nozzle tubing leaks with a soap solution with the nozzle capped by the flapper. Press on the nozzle cap gently to ensure the nozzle O-ring is sealing. Ensure the relay nozzle tubing nut is tight and the manifold screws (keys 34 and 131) are tight.	8.5 Tighten the relay nozzle tubing nut, tighten manifold screws (keys 34 and 131), or replace nozzle assembly O-ring or set point beam assembly as appropriate.

Changing Controller Action

The following steps describe changing controller action from direct (increasing process differential pressure produces increasing output pressure) to reverse (increasing process differential pressure produces decreasing output pressure) or vice versa.

1. Loosen two screws (key 6) in the proportional band indicator cover (key 36). Do not remove the screws.
2. Lift the proportional band indicator cover as shown in figure 5-2.
3. Rotate the proportional band knob (key 25) to the desired controller action.
4. Install the proportional band indicator cover (key 36) and tighten the two screws (key 6).

Figure 5-2. Changing Controller Action

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Replacing the Differential Pressure Unit

⚠ WARNING

Refer to the Maintenance WARNING at the beginning of this section.

Before performing any maintenance operations:

- Shut off the supply pressure to the controller.
- Disconnect any operating lines providing supply air pressure, a process input signal, or other pressure source to the controller.

Refer to figures 6-1 and 6-2 for key number locations.

Use this procedure in reverse to connect a differential pressure unit to a controller.

1. Is the process under temporary control? If so, shut off the process differential pressure to the differential pressure unit. Also, shut off the supply pressure to the controller. Carefully bleed pressure from the controller and differential pressure unit.
2. Disconnect all tubing. Refer to the installation procedures for process and supply tubing connections to disconnect when the differential pressure unit is removed from the pipestand.

⚠ WARNING

The combined weight of the controller and differential pressure unit is approximately 26 kilograms (57 pounds). Provide adequate support for the unit during removal procedures to prevent personal injury or property damage.

3. Remove the controller and differential pressure unit from the mounting position. Figure 2-1 shows the location of the set screws connecting the differential pressure unit mounting bracket to the pipestand. Move the controller and differential pressure unit to a maintenance area.

Properly support the unit before trying to separate the controller and differential pressure unit.

4. To separate the controller and differential pressure unit, open the cover, locate link 1 (key 323, figure 6-2) and disconnect it from the drive arm (key 322).
5. Remove the pivot bracket (key 320) by removing the screws and washers (keys 329 and 332).
6. Loosen the locking screw (key 331) and slide the drive arm (key 322) off the extension shaft.

CAUTION

When removing the controller from the controller mounting plate (key 327), be careful not to bend the extension shaft (key 321).

7. Remove four screws (key 336) from the controller mounting plate (key 328) and carefully slide the controller off the extension shaft.
8. For controller maintenance — remove the controller mounting plate (key 328) by removing three screws (key 335) to gain access to the back of the controller.
9. For differential pressure unit maintenance — loosen the set screw (key 333) and remove the extension shaft.
10. Remove four screws (key 334) from the mounting plate (key 327) to gain access to the differential pressure unit.
11. For maintenance of the differential pressure unit, refer to the instruction manual for the unit.

CAUTION

When reinstalling the differential pressure unit, carefully insert the extension shaft (key 321) into the controller to avoid damage to controller parts.

When reassembling the pivot bracket, it must be carefully aligned so that it will not cause binding on the extension shaft (key 331).

12. Follow this procedure in reverse to rejoin the controller and differential pressure unit. Before returning the unit to process control, perform maintenance calibration and flapper alignment procedures.

Refer to the installation procedures when reinstalling the unit.

Replacing Controller Parts

⚠ WARNING

Refer to the Maintenance WARNING at the beginning of this section.

To avoid personal injury or property damage caused by the uncontrolled release of pressure, be sure any trapped pressure is properly vented from the differential pressure unit. Vent any supply pressure from the controller before disassembly.

Note

Remove the controller and differential pressure unit to a maintenance area to perform the following procedures. Refer to the installation procedures for process and supply tubing connections to disconnect when the differential pressure unit is removed from the pipestand. Figure 2-1 shows the location of the set screws connecting the differential pressure unit mounting bracket to the pipestand.

Refer to the installation procedures when reinstalling the unit.

Note

In the following procedures, adjust the proportional band knob between DIRECT and REVERSE. If this is done, it will be necessary to set the proportional band knob to 400 DIRECT or REVERSE (direct or reverse action) before replacing the proportional band indicator cover.

Replacing the Process Differential Pressure Scale

CAUTION

Take care not to bend the process indicator or the set point adjustment while performing the following procedure.

Refer to figure 5-3.

Figure 5-3. Changing the Scale

W3440

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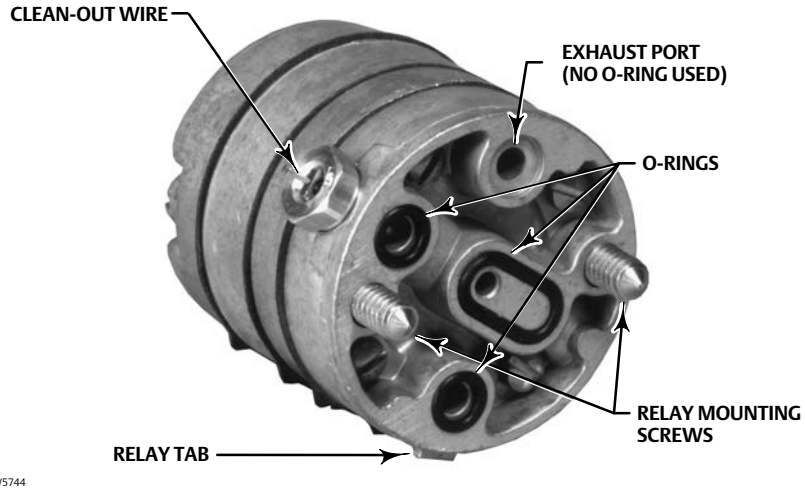
1. Adjust the set point adjustment manually or with the remote set point pressure to 50 percent of scale range.
2. Remove the four self-tapping screws (key 37).
3. Slide the process scale (key 61) so the top of the slot touches the set point adjustment. Deflect the lower portion of the slot and carefully slide the scale upward and off, clearing the set point adjustment as shown in figure 5-3.
4. To install the replacement scale, bend the lower part of the slot slightly so the scale slides downward over the set point adjustment and under the process indicator.
5. Secure the scale with the four self-tapping screws (key 37).
6. If the controller has the remote set point option, perform the appropriate remote set point calibration procedure.
7. Perform the appropriate process indicator zero-and-span adjustment and the flapper alignment in the calibration procedures in Section 3 or 4.

Replacing the Relay

1. Loosen the two captive screws holding the relay (key 50) in place.

2. Tip the relay slightly toward the side of the case to clear output pressure gauge and lift out the relay.
3. Make sure the replacement relay has three O-rings as shown in figure 5-4. The fourth port is for exhaust and does not require an O-ring.
4. Install the replacement relay, making sure the tab on the relay lines up with the tab on the frame (figure 5-4).
5. Install and tighten the two screws holding the relay in place.

Figure 5-4. Relay Features



6. Perform the appropriate flapper alignment procedure in Section 3 or 4.

Replacing the Case and Cover

CAUTION

The case and cover are an integral unit; trying to separate them will damage the hinge. If the cover needs to be replaced, replace the case also.

Note

To remove the controller from the case, first perform steps 1 through 7 of the Replacing the Differential Unit procedure. Then continue on with step 1 below.

1. Perform the procedure required in the Note above to remove the differential pressure unit from the controller.
2. Open the controller case and remove the nine screws (key 38) from the case and cover assembly (key 1). If the controller has remote set point (suffix letter M), pry the case slightly to remove the frame (key 3). Inspect the O-rings and replace as necessary.
3. Install the controller assembly in the replacement case.
4. Slide the controller frame down to assure an O-ring seal at the pressure connection. Hold the frame in place.
5. Install and tighten the nine mounting screws.
6. Remove the blow-out plug (key 72) from original case and install it in the replacement case.

7. Reinstall the differential pressure unit using the proper procedures.
8. Mount the controller as described in the Installation section.
9. Connect the supply pressure and output piping to the controller. Connect the process differential pressure to the differential pressure unit.
10. Perform necessary calibration steps.

Replacing the Gauges

CAUTION

Before performing this procedure, be sure the replacement gauges are the correct range so the gauges are not damaged by overpressure.

1. Unscrew the output gauge (key 46) or the supply gauge (key 47) from the frame (key 3).
2. Before installing the replacement gauge, coat the threads on the gauge with a suitable sealant.
3. Screw the replacement gauge into the frame.
4. Apply the correct supply pressure and check for leaks with the nozzle capped for full output pressure.

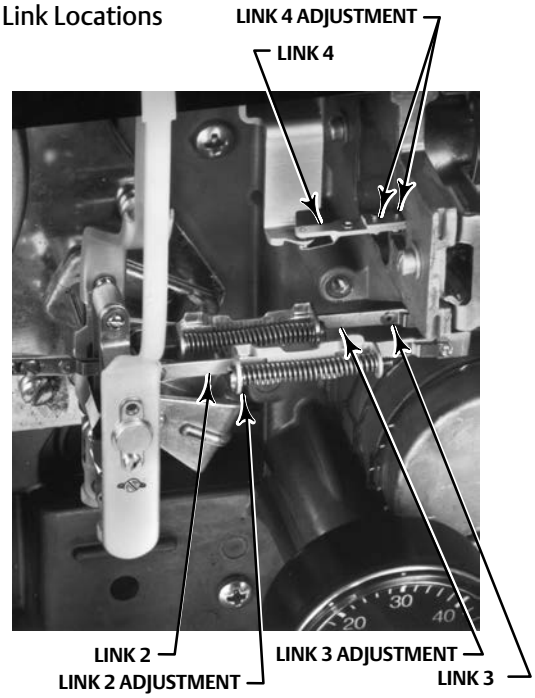
Replacing the Links

This section describes the separate replacement of four links in the controller. To clarify the location of each link, the links are numbered as follows:

- Link 1 connects the drive arm and the process indicator.
- Link 2 connects the process indicator and the input feedback beam assembly (key 11).
- Link 3 connects the set point adjustment and the set point beam assembly (key 23).
- Link 4 (key 65) connects the input feedback beam assembly and the bellows bracket assembly (key 31).

Figure 5-5 show the location of each link.

Figure 5-5. Link Locations



Link 1

Note

Before performing the following link 1 maintenance steps, disconnect supply pressure from the controller.

1. Note where the link is connected. Disconnect the link from the drive arm and from the process indicator assembly. Remove the link. Then, install the replacement link.
2. Attach the replacement link to the process indicator assembly and drive arm in the position noted in step 1. If, during the process indicator zero-and-span adjustment, the indicator will not travel full scale even after full span adjustment, move the link to the bottom hole. If the indicator has too much travel, move the link to the top hole.
3. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Move the set point adjustment manually, or with remote set point pressure, to 50 percent of the scale range. Set the proportional band between DIRECT and REVERSE.
5. The process indicator should be lined up with the subassembly (as shown in figure 5-6). If not, loosen the zero adjustment locking screw. Then, adjust the fine zero adjustment to align the indicator and subassembly.
6. With a regulated air supply, adjust process differential pressure to 50 percent of process scale range. The process indicator should be within ±3 percent of mid-range on the scale. If not, loosen the two screws in link 1 and move the process indicator to within ±3 percent of mid-range on the scale. Then, tighten the screws.
7. Perform the controller calibration procedure and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.

Figure 5-6. Process Indicator Alignment

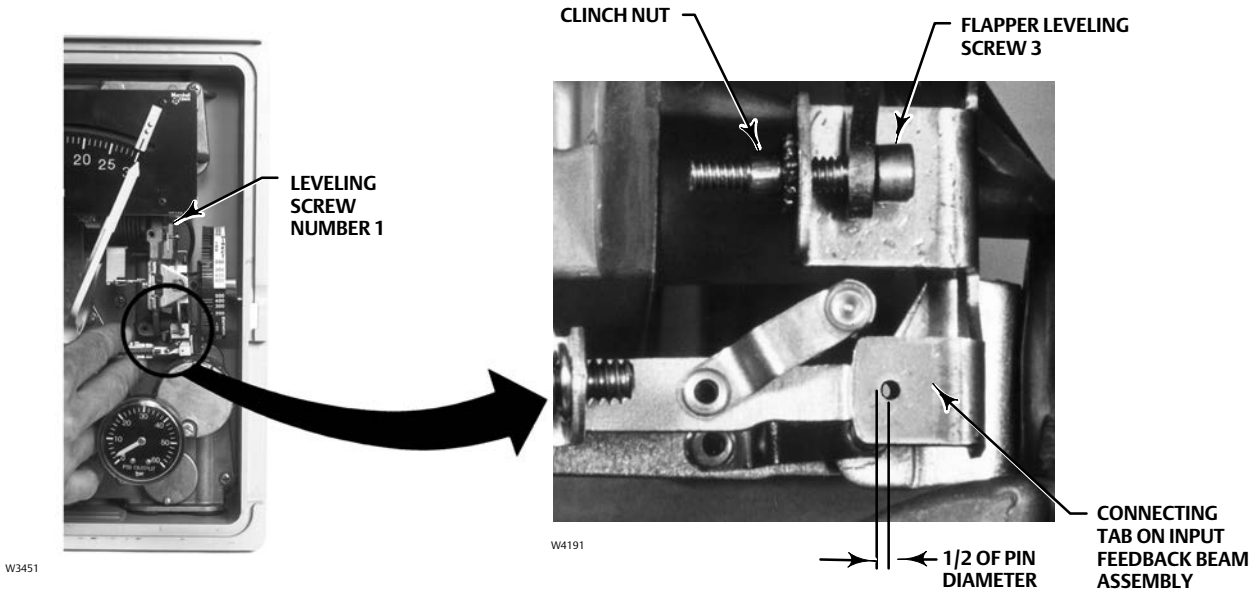
Link 2

Note
Before performing the following link 2 maintenance steps, disconnect supply pressure from the controller.

1. Remove two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Note where the link is connected. Disconnect the link from process indicator assembly and from the input feedback beam assembly (key 11). Remove the link.
3. Install the replacement link with the screw head nearest the process indicator as shown in figure 5-5. Connect the link to the process indicator assembly only and in the position noted in step 2.
4. The process indicator should be lined up with the indicator subassembly (as shown in figure 5-11). If not, loosen the zero adjustment locking screw and adjust the process indicator zero adjustment to align to the process and indicator subassembly.
5. Adjust the set point adjustment manually or with the remote set point pressure to 100 percent of scale range. Set the proportional band between DIRECT and REVERSE. Disconnect link 1 from the drive arm and position the process indicator to 100 percent of the scale. Tape the indicator in place.
6. Move the set point adjustment either manually or with the remote set point pressure to 0 percent on the scale. Set the proportional band at 5 percent REVERSE (reverse action). The nozzle should not be touching the flapper. If it is, adjust flapper leveling screw number 1 until clearance is obtained.

7. Adjust the length of link 2 by turning the adjusting screw (see figure 5-7) clockwise to increase length, or counterclockwise to decrease length so the pin on the end of the link is approximately **one-half** of its diameter short of engaging with the hole in the flapper assembly as shown in figure 5-9. This adjustment provides the proper tension on the link to eliminate lost motion.
8. Remove the tape from the process indicator.
9. Connect link 2 to the input feedback beam assembly.
10. Connect link 1 to the drive arm.
11. Perform the controller calibration procedure and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.

Figure 5-7. Link Number 2 Adjustment



Link 3

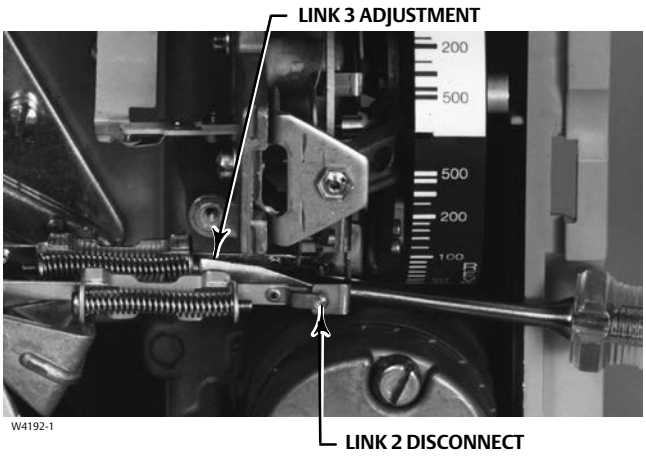
Note

Before performing the following link 3 maintenance steps, disconnect supply pressure from the controller. The link 3 procedure provides a non-pressurized alignment of the flapper before calibration.

The following steps provide initial alignment between link 3 and the flapper.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Note where the link is connected. Disconnect link 3 from set point adjustment assembly and the set point beam assembly (key 23).
3. Adjust the replacement link to the same length as the current link.
4. Install the replacement link with the screw head toward the set point beam assembly as shown in figure 5-8 and in the position as noted in step 2.

Figure 5-8. Link Number 3 Adjustment



5. Check the set point beam bias spring (key 28). Is it correctly located in the frame bore and spring seat on the set point beam assembly as shown in figure 5-9?
6. Move the set point adjustment indicator to 50 percent of scale range.
7. Adjust the process differential pressure until the process indicator is at 50 percent of the scale range.
8. Adjust the proportional band to 5 percent direct action. Turn the flapper leveling screw number 3 until the nozzle just touches the flapper.

Note

Flapper leveling screws 1 and 3 should protrude the same distance from the clinch nuts. See figure 5-7.

9. Adjust the proportional band to 5 percent REVERSE (reverse action). Turn flapper leveling screw number 1 until the nozzle just touches the flapper.

   If flapper leveling screw 1 protrudes farther than flapper leveling screw 3, turn the adjusting screw in link 3 **counterclockwise**. If flapper leveling screw 3 protrudes farther than flapper leveling screw 1, turn the adjusting screw in link 3 **clockwise**.

10. Repeat steps 8 and 9 until flapper leveling screws 1 and 3 protrude an equal distance from the clinch nuts.
11. Perform the pressurized maintenance calibration and flapper alignment procedures.

Link 4

1. Remove the two screws (key 6) and lift off the proportional band cover (key 36).
2. Refer to figure 5-5 for location of link 4. Note where the link is connected. Disconnect the link from bellows bracket assembly (key 31) and the input feedback assembly (key 11).
3. Connect the replacement link to the input feedback assembly so the two adjusting screws on the link are nearest to the feedback bellows bracket. The screw heads should face the bottom of the controller as shown in figure 5-12 and be positioned as noted in step 2.

4. For controllers with reset (4194HB controllers) or rate and reset (4194HC controllers), disconnect the supply pressure and then adjust the rate (4194HC controllers, only) to OFF. The controller output pressure must be 0 bar. Adjust the reset to 0.01 minutes per repeat and wait 30 seconds. Then, turn the reset adjustment to the CLOSED (4194HB controllers) or OFF (4194HC controllers) position.

   The controller output must be 0 bar. To be sure the controller output is at 0 bar, remove supply pressure, set the reset adjustment to 0.01 minutes per repeat and wait 30 seconds; then turn the the reset adjustment to the CLOSED (4194HB controllers) or OFF (4194HC controllers) position.

5. Adjust the proportional band to 5 percent REVERSE (reverse action) and move the set point adjustment indicator to 100 percent of the scale range.
6. Apply the correct supply pressure to the controller. The output of the controller should be within 0.14 bar (±2 psig) of the supply pressure. If not, adjust the flapper leveling screw number 1 (figure 3-1) until the output is within 0.14 bar (±2 psig) of supply pressure.
7. Loosen the two adjusting screws on link 4. Connect the free end of the link to the bellows bracket and allow the link to find its free length.
8. Tighten the two adjusting screws on the link.
9. The process indicator should indicate 50 percent of the process scale. If not, loosen the screws in **link 1** and adjust the indicator to 50 percent, ±3 percent, of scale span. Tighten the two screws.
10. Perform the controller calibration procedure and flapper alignment procedure.

Replacing the Supply, Proportional, Reset, Reset Valve, and Relief Tubing Assemblies

Note

Before starting the following procedure, remove the controller from the case. Perform steps 1 through 7 of the Replacing the Differential Pressure Unit procedure. Then, perform steps 1 and 2 of the Replacing the Case and Cover procedure.

Refer to figure 6-1 for key number locations.

1. Remove the nuts holding the supply gauge tubing assembly (key 39) and the proportional tubing assembly (key 40) to the frame. Remove the tubing.
2. Install the replacement tubing assemblies.
3. Set the reset adjustment to 0.01 (4194HB and HC controllers) and set the rate adjustment to OFF (4194HC controllers).
4. Apply the correct supply pressure and check for leaks. Then, remove pressure.
5. Install the controller assembly into the case. Slide the controller assembly down and make sure the O-rings (key 7) form a proper seal at the pressure connections. Hold the frame in place.
6. Install and tighten the nine self-tapping screws (key 38) into the frame.
7. Perform the process indicator zero-and-span adjustment and flapper alignment procedure in the Maintenance Calibration section.
8. Mount the assembled controller on a pipestand as described in the Installation section. Connect supply, output, and process differential pressure piping to controller/differential pressure unit.

Replacing the Proportional Band Adjustment Knob, Nozzle Assembly, and Set Point Beam Assembly

Note

Before starting the following procedure, remove the controller from the case. Perform steps 1 through 7 of the Replacing the Differential Pressure Unit procedure. Then, perform steps 1 and 2 of the Replacing the Case and Cover procedure.

Key numbers refer to figure 6-1.

Disassembly

1. Perform the procedures required in the Note above.
2. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
3. Disconnect link 3 from the set point beam shoe, part of the set point beam assembly (key 23). Refer to figure 5-9 for location of the link/shoe.
4. Remove the set point beam bias spring (key 28). Refer to figure 5-9 for spring location.
5. Remove the screw and washer (keys 19 and 20) holding the bracket of the set point pivot assembly to the frame. Remove the pivot assembly from the set point beam assembly.
6. Disconnect the nut holding the relay nozzle tubing into the frame manifold (key 3).
7. While holding the proportional band knob, remove the screw and washer (keys 19 and 20) which holds the bracket of the relay nozzle tubing assembly (key 18) to the frame.
8. Remove the proportional band knob nozzle pivot and set point beam assembly from the controller frame.
9. Pull the relay nozzle tubing assembly (key 18) from the bore in the set point beam assembly (key 23).
10. Remove the E-ring (key 27) holding the retaining clip, proportional band knob, and nozzle assembly together with the set point beam assembly.
11. Pull the nozzle assembly (key 21) from the set point beam assembly. Do not lose the plastic washer (key 22).
12. Remove the retaining clip (key 26).
13. Remove the proportional band knob (key 25) from the set point beam assembly (key 23). Do not lose the plastic washer (key 22).
14. Inspect the nozzle assembly O-ring. Replace it, if necessary.
15. First, inspect the nozzle orifice and clean it, if necessary. Then, inspect the entire nozzle assembly (key 21) and replace it, if necessary.

Assembly

1. Lubricate (key 318) and install the proportional band knob (key 25) on the set point beam assembly (key 23).
2. Install the retaining clip (key 26) on the three posts on the proportional band knob.
3. Lubricate the nozzle assembly O-ring and install the nozzle assembly (key 21) through the set point beam assembly (key 23), the proportional band knob (key 25) and the retaining clip (key 26) into the cap, aligning the nozzle with the tab on the proportional band knob (shown in figure 5-10).
4. While holding the nozzle tubing (key 21) against the set point beam assembly (key 23), depress the retaining clip (key 26) and install the E-ring (key 27) into the E-ring groove on the nozzle tubing assembly (key 18). Be sure all three corners of the E-ring are engaged.

5. Inspect the O-ring on the relay nozzle tubing assembly (key 18) and replace it if necessary. Apply a suitable lubricant (key 318) to the O-ring.
6. Install the relay nozzle tubing assembly (key 18) by pushing it into the bore in the set point beam assembly.
7. Adjust the proportional band between DIRECT and REVERSE. Do this by aligning the tab on the proportional band knob with the hole in the set point beam assembly as shown in figure 5-10.
8. Position the proportional band knob, nozzle pivot and the set point beam assembly on frame. Install the relay nozzle tubing nut loosely into frame manifold while positioning the nozzle in the center of the flapper as shown in figure 5-11.
9. Secure the set point pivot assembly (key 17) to the frame as shown in figure 5-9. Install the screw and washer (keys 19 and 20) through the frame (key 3) into the set point pivot bracket. Do not tighten.
10. Secure the relay nozzle tubing assembly(key 18) to the frame as shown in figure 5-9. Install the screw and washer (keys 19 and 20) through the frame (key 3) and into the relay nozzle tubing pivot bracket. Tighten both this screw and the screw installed in step 9.

    Make sure the nozzle remains centered on the flapper with the set point beam assembly resting snugly down on the relay nozzle tubing assembly.
11. Tighten the nut on the relay nozzle tubing assembly (key 18) and apply full supply pressure to check for leaks with the controller developing full output pressure.
12. Turn the proportional band adjustment knob to 5 percent direct action. Loosen the locking nut (figure 5-9) on the adjustable set point pivot assembly and back the set screw out slightly so the set point beam assembly falls under its own weight when pivoted upward, with minimum set point beam sideplay between the pivots. Tighten the locking nut.
13. Install the set point beam bias spring (key 28) into the bore of the frame (key 3) and onto the spring seat on the set point beam assembly (see figure 5-9).
14. Attach link 3 to the set point beam assembly (key 23). See figure 5-9.
15. Tighten the nut on the relay nozzle tubing assembly (key 18). Apply full supply pressure with the nozzle capped and check for leaks.
16. For controllers with reset or rate (4194HB or 4194HC controllers), disconnect the supply pressure. Then, adjust the reset adjustment to the CLOSED (4194HB) or OFF (4194HC) position and adjust the rate adjustment to the OFF position.

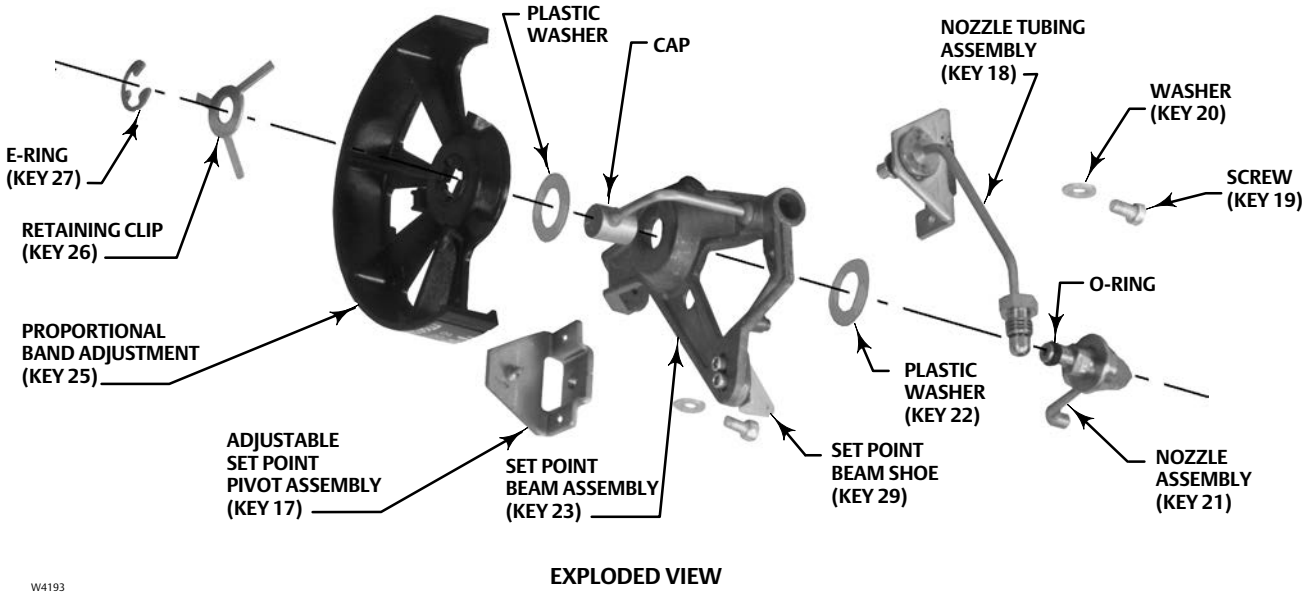
    Controller output pressure must be 0 bar (0 psig). Set the reset adjustment to 0.01 minutes per repeat and wait 30 seconds. Then, turn the reset adjustment to the CLOSED position (4194HB) or to the OFF position (4194HC).
17. Connect supply pressure and a regulated process differential pressure to the controller. Also, provide a means of measuring controller output pressure.
18. Perform the appropriate process indicator zero-and-span calibration procedure and, if necessary, the remote set point calibration procedure in Section 3 or 4. When calibration is complete, continue with step 19 below.

Note

The following procedure (steps 19 through 29) matches the process indicator motion to the set point indicator motion so the controller will control at set point at all positions on the process scale.

19. Adjust the proportional band to 40 percent DIRECT or REVERSE (direct or reverse action) depending on the desired controller action.

Figure 5-9. Proportional Band Knob and Set Point Beam Details



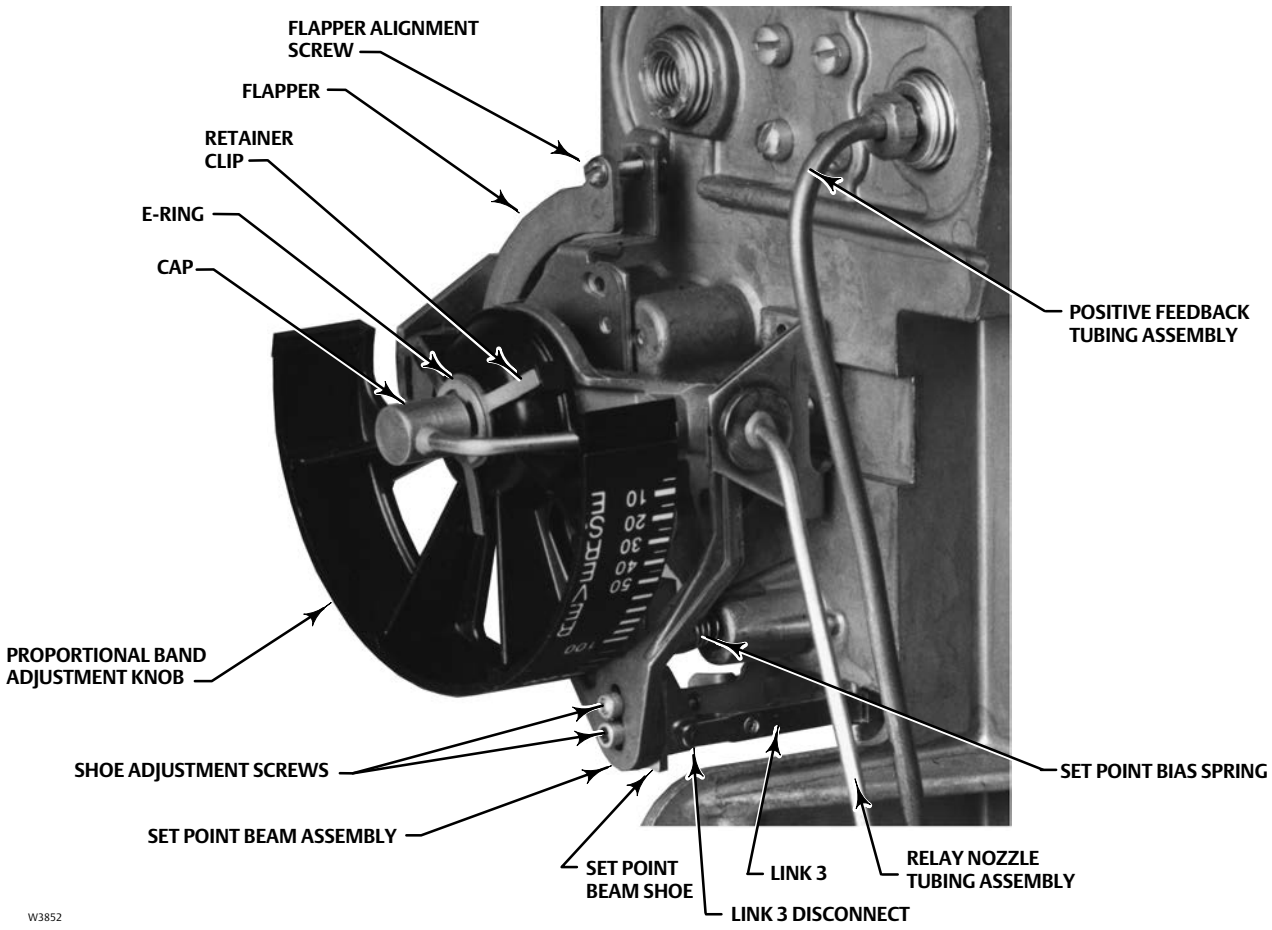


Figure 5-10. Proportional Band Adjustment Knob Alignment

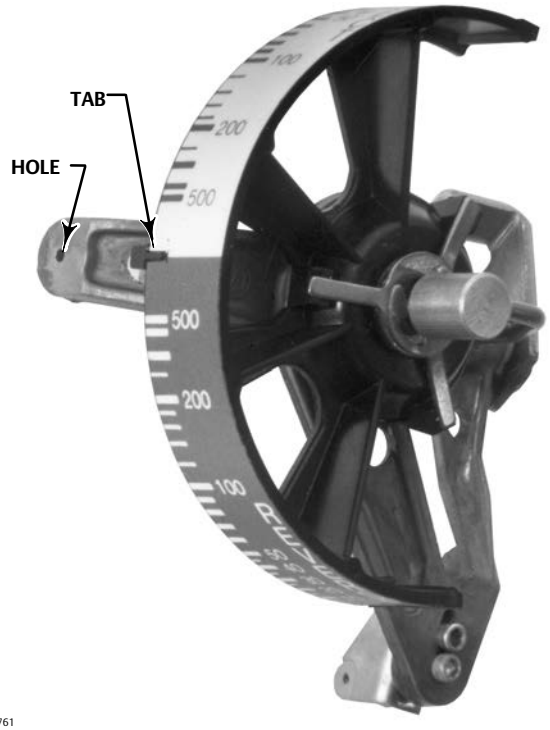
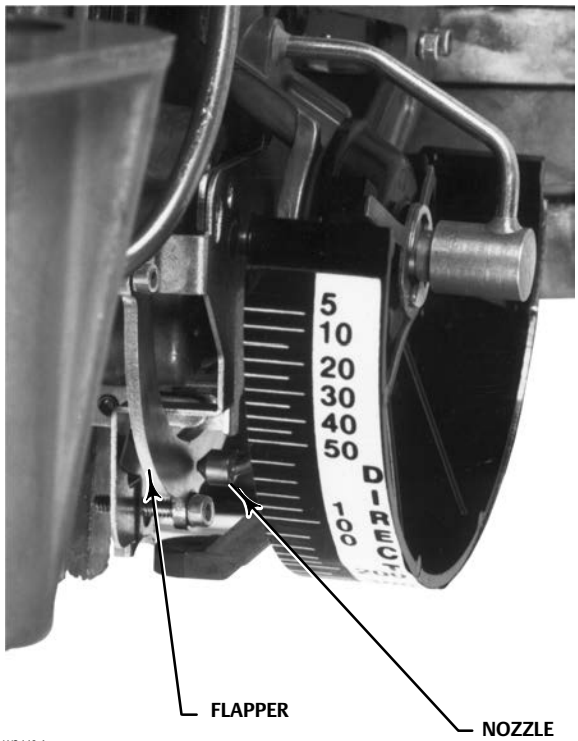


Figure 5-11. Nozzle-Flapper Alignment



20. Adjust the set point to the minimum value on the process scale.
21. Disconnect link 1 from the drive arm and tape the process indicator to the minimum scale value. Record the controller output pressure. Output pressure reading can be anywhere from 0.2 to 1.0 bar (3 to 15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output signal range or 0.4 to 2.0 bar (6 to 30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output signal range. If the output is not within the specified range, adjust the flapper leveling screw nearest the nozzle until the output is within the range specified. See figure 3-1 for the location of the flapper leveling screws.
22. Adjust the set point to the maximum value on the process scale.
23. Remove the tape and move the process indicator until the controller output equals the pressure recorded in step 21.
24. If the process differential pressure indication in step 23 is greater than the maximum scale value by 2 percent, loosen the shoe adjustment screws (key 30) and move the set point beam shoe (key 29) slightly down from the center of the flapper assembly (see figure 5-9).

    If the process differential pressure indication in step 27 is at least 2 percent less than the maximum scale value, move the set point beam shoe (key 29) slightly upward toward the center of the flapper assembly.
25. Repeat steps 20 through 24 until the error is less than 2 percent of process scale span at the maximum process scale value.
26. Reattach link 1 to the drive arm.
27. Install the controller assembly in the case and cover.
28. Refer to the flapper alignment procedures.
29. Replace the proportional band indicator cover (key 36) and tighten two screws (key 6).

Replacing the Flapper Assembly and Flexure Pivot Assembly

Note

Before starting the following procedure, remove the controller from the case. Perform steps 1 through 7 of the Replacing the Differential Pressure Unit procedure. Then, perform steps 1 and 2 of the Replacing the Case and Cover procedure.

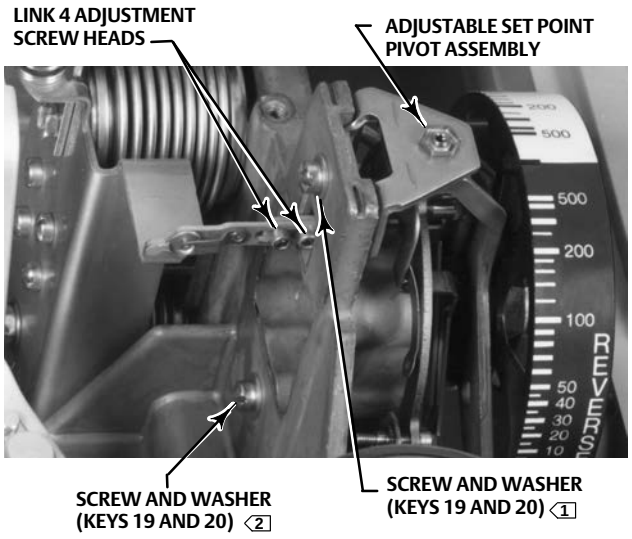
1. Perform the procedures required in the Note above.
2. Remove the two screws and lift off the proportional band indicator cover.
3. Disconnect link 3 from the set point beam shoe. Refer to figure 5-9 for link location.
4. Remove the set point beam bias spring. Refer to figure 5-9 for the spring location.
5. Remove the screw and washer (keys 19 and 20, figure 5-12) holding the set point pivot assembly to the frame.
6. Remove the set point pivot assembly.
7. Disconnect the nut holding the relay nozzle tubing (key 18, figure 5-9) into the frame.
8. While holding the proportional band knob, remove the screw and washer (keys 19 and 20, figure 5-12) which holds the relay nozzle tubing assembly (key 18) to the frame manifold (key 135).
9. Remove the proportional band knob nozzle pivot, relay nozzle tubing assembly, and set point beam assembly from controller.
10. Disconnect link 2 from the input feedback beam assembly (key 11) shown in figure 5-7.
11. Disconnect link 4 from the bellows bracket (key 31).
12. Remove the two screws (key 12) that hold the flexure pivot assembly (key 9) to the input feedback beam assembly. See figure 5-13 for screw location.
13. Remove the input feedback beam assembly as shown in figure 5-14.
14. Remove the four screws (key 10) as shown in figure 5-14 holding the flexure pivot assembly to the frame.
15. Remove the flexure pivot assembly (key 9).
16. Install the replacement flexure pivot assembly with the four screws (key 10). Do not tighten the screws.
17. Move the flexure pivot assembly towards the relay as far as possible and tighten the four screws (key 10).
18. Place the input feedback beam assembly (key 11) onto the flexure pivot assembly (key 9) with link 4 through the square hole in the frame.
19. Install the screw (key 12) with the washer (key 13) through the input feedback beam assembly (key 11) into the flexure pivot assembly (key 9). Do not tighten the screw.
20. Align flapper leveling screw number 2 with the centerline of the oblong hole in the frame as shown in figure 5-13. Tighten the screw (key 12). Make sure link 4 does not touch the frame.

Note

The following procedure (steps 22 through 24) adjusts link 2 so it will always be in tension. This eliminates possible instability due to lost motion.

21. Disconnect link 1 (figure 3-1) from the drive arm/pivot assembly and manually position the process indicator to 100 percent of the scale. Tape the indicator in position.

Figure 5-12. Position of Link Number 4 Adjustment Screws



NOTES:
1 SCREW INSERTED INTO THE ADJUSTABLE SET POINT PIVOT ASSEMBLY.
2 SCREW INSERTED INTO THE RELAY NOZZLE TUBING ASSEMBLY.

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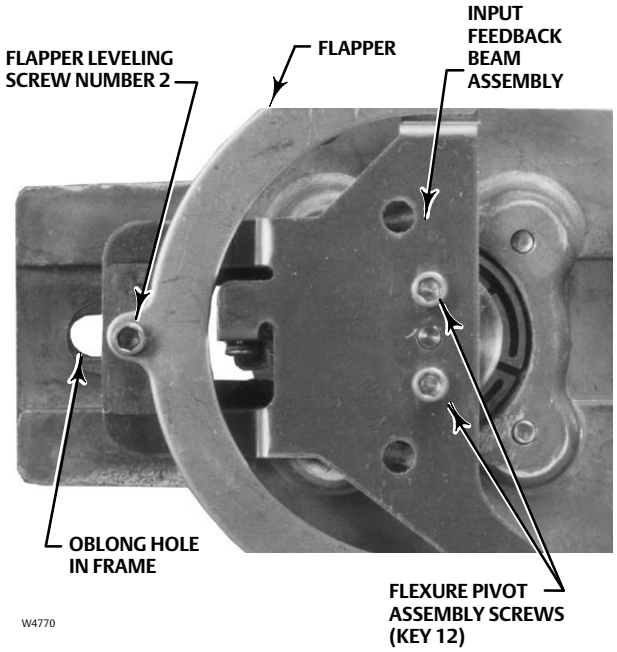
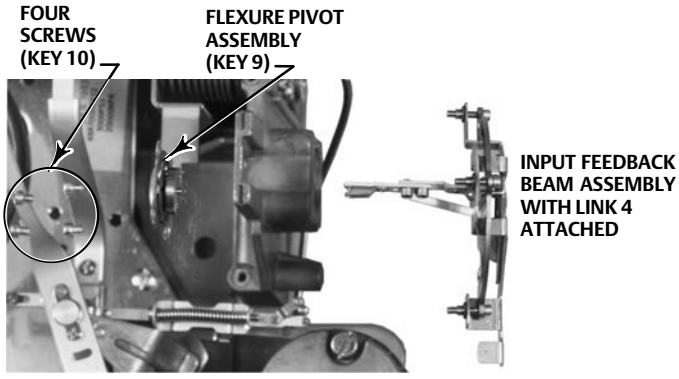
Figure 5-13. Flapper Assembly and Leveling Screws


FLAPPER LEVELING SCREW NUMBER 2
FLAPPER
INPUT FEEDBACK BEAM ASSEMBLY
OBLONG HOLE IN FRAME
FLEXURE PIVOT ASSEMBLY SCREWS (KEY 12)

W4770

Figure 5-14. Exploded View, Flexure Pivot Assembly



W4198

22. Adjust the length of link 2 by turning the adjustment screw clockwise to increase the length or counterclockwise to decrease the length so the pin on the end of the link is approximately **one-half** of its diameter short of aligning with the hole in the input feedback beam assembly, as shown in figure 5-7.
23. Connect link 2 to the input feedback beam assembly.
24. Connect link 1 to the drive arm.
25. Adjust the proportional band between DIRECT and REVERSE. Do this by aligning the tab on the proportional band knob with the hole in the set point beam assembly as shown in figure 5-10.

26. Position the proportional band knob, nozzle pivot, and set point beam assembly on frame. Install the relay nozzle tubing nut loosely into frame manifold while positioning the nozzle in the center of the flapper as shown in figure 5-11.
27. Install the washer (key 20) on the screw (key 19).
28. Install the screw (key 19) through the frame (key 3) and into the relay nozzle tubing assembly (key 18). Tighten the screw. Be sure the nozzle remains centered on the flapper with the set point beam assembly slid snugly towards the relay nozzle tubing assembly.
29. Install washer (key 20) on screw (key 19).
30. Install the screw (key 19) through the frame (key 3) into the set point pivot assembly (key 23). Do not tighten.
31. Slide the set point pivot assembly (key 17) toward the set point beam until the cone lightly contacts the set point beam and tighten the screws. The proportional band knob should fall freely when the controller is in the upright position. If it does not, reposition the set point pivot assembly (key 17).
32. Tighten the relay nozzle tubing nut (key 18). Apply full supply pressure and check for leaks. Disconnect the supply pressure.
33. Install the set point beam bias spring (key 28) into frame (key 3) bore and onto spring seat on the set point beam assembly (key 23).
34. Attach link 3 to the set point beam assembly.

Note

The following procedure (steps 35 through 45) adjusts link 4 so it will always be in compression to eliminate possible instability due to lost motion.

35. For controllers with reset or rate adjustments (4194HB or 4194HC controllers), disconnect the supply pressure and adjust the rate to OFF. Controller output must be 0 bar (0 psig). Set the reset adjustment to 0.01 minutes per repeat and wait 30 seconds. Then, turn the reset adjustment to CLOSED (4194HB) or OFF (4194HC) position.
36. Apply proper supply pressure to the controller and provide an accurate means of measuring the controller output pressure.
37. Adjust the proportional band to 5 percent REVERSE (reverse action) and adjust the set point to the maximum value on the process scale.
38. With link 1 still disconnected, tape the process indicator at the minimum process scale value (the last mark on the left side of the scale). The output pressure should be within 0.07 bar (2 psig) of the supply pressure. If not, adjust flapper leveling screw number 1 until the output is within 0.14 bar (2 psig) of supply pressure.
39. Loosen the two adjustment screws on link 4 (see figure 5-5) and connect the link to the bellows bracket (key 31), allowing the link to find its free length.
40. Tighten the two adjusting screws on link 4 (see figure 5-5).
41. Raise link 4 out of the hole in the bellows bracket (key 31) and ensure it drops back into the hole under its own weight. If not, repeat steps 39 and 40.
42. Perform steps 20 through 26 in the maintenance procedure for the proportional band adjustment knob, nozzle assembly, and set point beam assembly.
43. Remove the tape from the process indicator and reconnect link 1 to the drive arm. For 4194HB and 4194HC controllers (controllers with reset), turn the reset adjustment to 0.01.
44. Install the controller assembly in the case and cover.
45. Refer to the process indicator zero-and-span adjustment and flapper alignment procedures in the Maintenance section.

Replacing the Proportional or Reset Bellows

Note

Before starting the following procedure, remove the controller from the case. Perform steps 1 through 7 of the Replacing the Differential Pressure Unit procedure. Then, perform steps 1 and 2 of the Replacing the Case and Cover procedure.

1. Perform the procedures required in the Note above.
2. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
3. Disconnect link 4 (key 65) from the bellows bracket (key 31).
4. Remove the two machine screws (key 35, figure 5-15) and washer (key 362) from the bellows assemblies.
5. Remove the four machine screws (key 6, figure 5-15) from the bellows beam (key 49). Then, remove the bellows bracket (key 31).
6. Remove the proportional tubing assembly (key 40) from the proportional bellows and/or remove the reset tubing assembly (key 43) from the reset bellows, depending on which bellows are to be replaced.
7. Remove the four machine screws (key 71) from the bellows beam and remove the bellows beam from the frame (key 3).

CAUTION

When removing and replacing the proportional or reset bellows, keep in mind the bellows has left-hand threads. Overtightening could damage the threads.

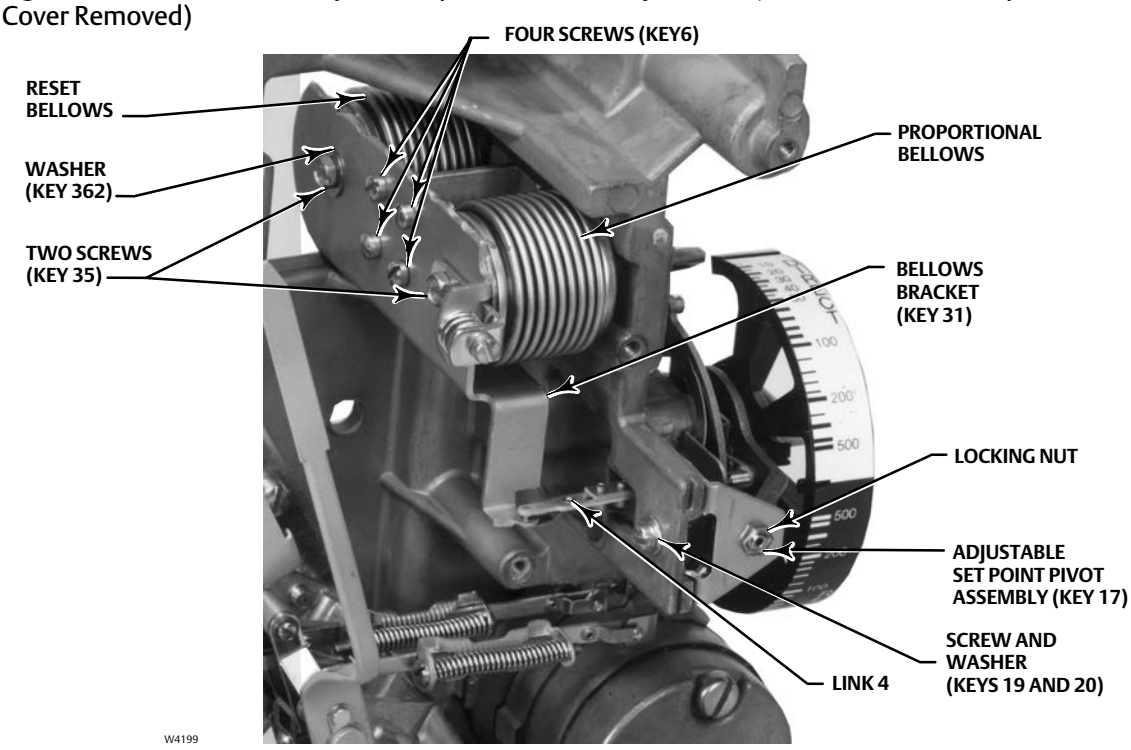
Note

Do not remove both bellows if only one requires replacement.

8. Unscrew the bellows (key 48). If the bellows assembly cannot be removed by hand, thread a machine screw (key 35) into the bellows until tight; loosen the bellows assembly by applying clockwise torque to the machine screw.
9. Before installing the replacement bellows, coat the threads with a suitable lubricant, such as key 310. Screw in the replacement bellows until it is finger tight against the frame (key 3).
10. Reinstall the bellows beam (key 49) and tighten the machine screws (key 71).
11. Compress the bellows and install the two screws (key 35) and washer (key 362) through the bellows bracket (key 31) into the bellows. Do not tighten. The washer must be under the screw threaded into the reset bellows (see figure 5-15 for the location of the reset bellows).
12. Install the four machine screws (key 6) through the bellows bracket (key 31) into the bellows beam (key 49) but do not tighten. Be sure the bellows bracket is aligned so it does not rub on the frame (key 3) at any point. Tighten the screws (keys 6 and 35, figure 5-15).
13. Install the proportional and/or reset tubing assembly on the bellows (key 48) base.
14. Adjust the reset valve to 0.01 minute per repeat (4194HB or 4194HC). Adjust the rate valve to OFF (4194HC). Apply the correct supply pressure with the nozzle capped and check for leaks. Remove the supply pressure.
15. Replace link 4 (key 65) on the bellows bracket. Be sure the link does not contact the frame (key 3). If it does, loosen the four screws (key 6) which attach the bellows bracket (key 31) and reposition the bracket to provide clearance. Be sure the bellows bracket does not rub on the frame.

16. Refer to steps 4 through 10 in the procedure for replacing link 4. If the controller is a proportional-only (4194HA) controller, go to step 28. If the controller has reset (4194HB) or rate/reset (4194HC), continue with step 17 and the following note.
17. Disconnect link 1 from the drive arm.

Figure 5-15. Bellows Assembly and Proportional Band Adjustment (Process Scale and Proportional Band Adjustment Cover Removed)



Note

The following procedure (steps 18 through 28) adjusts the reset gain of the controller to minimize steady-state offset.

18. Adjust the proportional band to 100 percent in direct action.
19. Adjust the set point to 50 percent of the process scale range.
20. Adjust the reset valve (4194HB and HC controllers) to 0.01 minute per repeat. Adjust the rate valve (4194HC controllers) to OFF.
21. Increase the process differential pressure to the differential pressure unit until the output pressure stabilizes at 0.2 bar (3 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output signal range or 0.4 bar (6 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output signal range. Record the process differential pressure reading.

Note

When the reset valve is at 0.01, the controller is very sensitive to any process differential pressure change. Only small changes to the process indicator may be necessary.

22. Increase the process differential pressure very slowly until the output pressure stabilizes at 1.0 bar (15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output signal range or 2.0 bar (30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output signal range. Record the process differential pressure reading.
23. If the difference between the recorded process differential pressure in step 21 and the process differential pressure in step 22 is larger than ±1 percent of the process differential pressure span, proceed with step 24. If the difference is less than ±1 percent, remove process differential pressure from the differential pressure unit/controller and go to step 28.
24. Loosen the proportional bellows screw (key 35, figure 5-15).
25. Adjust the gain screw (key 34) one-half turn in — if the reading recorded in step 22 is greater than in step 21. Adjust the gain screw (key 34) one-half turn out — if the reading in step 22 is less than in step 21.
26. Tighten the proportional bellows screw (key 35).
27. Repeat steps 21 through 26 until the difference is less than ±1 percent of the process differential pressure span.
28. If ±1 percent of process scale span cannot be achieved by adjusting the gain screw (key 34), loosen the screw (key 35) attaching the reset bellows and slide it to the left if the reading in step 22 is greater than in step 21, or to the right if the reading in step 22 is less than in step 21. Repeat steps 22 through 27.
29. Reconnect link 1 and install the controller assembly in the case and cover.
30. Refer to the process pointer zero-and-span adjustment and flapper alignment procedure in the Maintenance section.

Replacing the Reset Restriction Valve (4194HB Controllers)

Note
Before starting the following procedure, remove the controller from the case. Perform steps 1 through 7 of the Replacing the Differential Pressure Unit procedure. Then, perform steps 1 and 2 of the Replacing the Case and Cover procedure.

Refer to the 4194HB controller portion of figure 6-1 for key number locations.

1. Perform the procedures required in the Note above.
2. After removing the controller from the case and cover, remove the reset valve tubing assembly (key 42) from the reset restriction valve (key 54).
3. Remove the reset tubing assembly (key 43) from the reset restriction valve.
4. Remove the relief tubing assembly (key 44) from the reset restriction valve (option F only).
5. Remove the screw (key 162) holding the reset restriction valve to the frame (key 3).
6. Install the replacement reset restriction valve and secure it with the screw removed in step 5.
7. Install the reset valve tubing assembly (key 42), the reset tubing assembly (key 43), the relief tubing assembly (key 44, option F only) and tighten.
8. Set the reset restriction valve to 0.01 minute per repeat.
9. Apply the proper supply pressure to the controller, drive the controller output to within 0.14 bar (2 psig) of the supply pressure by capping the nozzle and check the tubing connections for leaks.
10. Install the controller assembly in the case and cover.

Replacing the Rate/Reset Valve Assembly (4194HC Controllers)

Note
Read this entire procedure before removing any parts. Refer to the 4194HC portion of figure 6-1 for key number locations.

Note
Before starting the following procedure, remove the controller from the case. Perform steps 1 through 7 of the Replacing the Differential Pressure Unit procedure. Then, perform steps 1 and 2 of the Replacing the Case and Cover procedure.

1. Perform the procedures required in the Note above.
2. Remove the two machine screws (key 71) on the side of the rate/reset valve assembly (key 262).
3. Gently pull the rate tubing assembly away from the rate/reset assembly and, remove the gasket (key 5) from the side of the rate/reset assembly.
4. Remove the nut holding the reset tubing assembly (key 43) into the rate/reset valve assembly.
5. Remove the nut holding the proportional tubing assembly (key 40) into the rate/reset assembly.
6. Remove the nut holding the relief tubing assembly (key 44, option F only) into the rate/reset assembly.
7. While holding the rate/reset valve assembly, remove the machine screw (key 162) from the frame.
8. Remove the rate/reset valve assembly from the frame.
9. Inspect and, if necessary, replace the gasket (key 5).
10. To install the replacement rate/reset valve assembly, insert the assembly into its position on the frame (key 3).
11. Insert the valve assembly mounting screw (key 162) into the valve assembly and tighten.
12. Insert the gasket (key 5) and hold it in place while installing the two machine screws (key 71) holding the rate tubing assembly (key 137) to the valve assembly and tighten the screws.
13. Insert the reset tubing assembly (key 43) into the rate/reset valve assembly and tighten the nut.
14. Insert the proportional tubing assembly (key 40) into the rate/reset valve assembly and tighten the nut.
15. Insert the relief tubing assembly (key 44, option F only) into the rate/reset valve assembly and tighten the nut.
16. Turn the reset to 0.01 and the rate valve to OFF.
17. Apply the proper supply pressure to the controller, drive the controller output to within ±0.14 bar (2 psig) of the supply pressure by capping the nozzle and check the tubing connections for leaks.
18. Install the controller assembly in the case and cover.

Replacing the Differential Relief Valve Assembly (suffix letter F)

Refer to the 4194HB or 4194HC option F portion of figure 6-1 for key number locations.

1. Loosen the two mounting screws in the differential relief valve (key 55) and remove the relief valve.
2. Inspect the O-rings on the replacement relief valve. Apply a suitable lubricant to the O-rings.
3. Install the replacement relief valve into the controller frame, keeping in mind that:
   - When the arrow points up, the valve relieves with decreasing output pressure.
   - When the arrow points down, the valve relieves with increasing output pressure.
4. Tighten the two screws holding the relief valve to the frame.
5. The relief valve differential pressure is factory-set at 0.3 bar (5 psig). Maximum pressure differential is 0.5 bar (7 psig); minimum pressure differential is 0.14 bar (2 psig). If a different differential pressure setting is desired, refer to the anti-reset windup valve calibration procedure in this manual.

Replacing the Relief Valve Tubing Assembly (suffix letter F)

Note
Before starting the following procedure, remove the controller from the case. Perform steps 1 through 7 of the Replacing the Differential Pressure Unit procedure. Then, perform steps 1 and 2 of the Replacing the Case and Cover procedure.

Refer to figure 6-1 (4194HB or 4194HC controllers, suffix letter F) for key number locations.

1. Perform the procedures required in the Note above.
2. Loosen the nuts at both ends of the relief valve tubing (key 44) and remove the tubing.
3. Install the replacement relief valve tubing and tighten the tubing nuts at both ends.
4. Apply the proper supply pressure to the controller. Check for leaks.
5. Install the controller assembly in the case and cover.
6. Perform the process zero-and-span adjustment procedure and the flapper alignment procedure.

Calibration After Controller Maintenance

⚠ WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure, do not exceed the operating limits given in this manual.

Process Indicator Zero-and-Span Calibration

Note

For routine zero-and-span calibration, refer to the appropriate procedures in Section 3 or 4. Use the following maintenance zero-and-span procedure only if difficulty is encountered with the routine procedure or if nonlinearity occurs.

Refer to figure 3-1 for location of adjustments and figure 6-1 for key number locations.

Provide a regulated process differential pressure to the differential pressure unit. Provide a regulated supply pressure to the controller. Do not exceed normal operating pressure (table 1-4). For a 4194HA controller, connect the controller output to an accurate gauge. For 4194HB and HC controllers, a gauge is not necessary and the controller output connection may be plugged.

Note

Any adjustment of the process indicator span adjustment screw requires readjustment of the process indicator zero adjustment screw.

1. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band adjustment between DIRECT and REVERSE.
3. Adjust the reset valve (4194HB and HC controllers only) to 0.01 minutes per repeat.
4. Adjust the rate valve (4194HC controllers only) to OFF.
5. Adjust the process differential pressure to 50 percent of the process scale range.
6. The process indicator should be aligned with the indicator subassembly as shown in figure 5-6. If not, loosen the zero adjustment locking screw and adjust the zero adjustment screw to align the process indicator with the indicator subassembly. Tighten the zero adjustment locking screw.

7. The process indicator should point out 50 ±3 percent of the input scale range. If not, loosen the screws in link 1 and move the process indicator to 50 ±3 percent. Tighten the screws.
8. The controller output pressure should be:

   c. For 4194HA controllers — 0.6 ±0.1 bar (9 ±1 psig) for a 0.2 to 1 bar (3 to 15 psi) output or 1.2 ±0.1 bar (18 ±2 psig) for a 0.4 to 2 bar (6 to 30 psi) output.

   d. For 4194HB and HC controllers — 0.0 bar (0 psig).

If necessary, adjust flapper leveling screw number 2 to obtain the required output pressure.

9. Adjust the process differential pressure to the differential pressure unit to 0 percent of the process differential pressure scale range.
10. Adjust the process indicator to 0 percent on the process scale by loosening the zero adjustment locking screw and turning the zero adjustment screw. Tighten the zero adjustment locking screw.
11. Adjust the process differential pressure to 100 percent of the scale range.
12. Note whether the process indicator is above or below 100 percent on the process scale.
13. Adjust the process indicator span adjustment as follows: clockwise to increase the span for a low indication and counterclockwise to decrease the span for a high indication. To avoid overcorrection, only correct for approximately one-half of the error with the span adjustment screw.
14. Repeat steps 9 through 13 until the process indicator is aligned with the process scale at the 0 percent and at the 100 percent marks. If the span adjustment screw is adjusted to its limit and the span is still too short or too long, proceed with step 15. If proper span is achieved, proceed to step 16.
15. Within the process indicator subassembly, there are three holes for the connection of link 1. Use procedure (a.) or (b.) below to make the coarse span adjustment with link 1.

    a. If the span is short (process indication is low at 100 percent of input range), disconnect link 1 from the process indicator subassembly, move the link to the lowest hole, and return to step 9.

    b. If the span is long, (process indication is high at 100 percent of the input range), disconnect link 1 from the process indicator subassembly, move the link to the highest hole, and return to step 9.

16. Adjust the process differential pressure to 50 percent of the process scale range. The process indicator should point out 50 ±2 percent on the process scale range. If the process indicator error is ±2 percent or less, proceed to step 19.
17. If the process indicator error is greater than ±2 percent, loosen the two screws in the drive arm (key 322, figure 6-2). Then, lengthen or shorten the drive arm 6.3 mm (1/4 inch) and repeat steps 9 through 16.
18. Adjust the process indicator to within ±1 percent of the 50 percent scale mark by loosening the zero adjustment locking screw and turning the zero adjustment screw. Tighten the zero adjustment locking screw. This will distribute the error over the entire process scale and keep all points within ±1 percent of the process scale span.
19. Adjust the process differential pressure to 0 and 100 percent of the process scale range to make sure the process indicator is still within ±1 percent of the 0 and 100 percent scale marks.
20. Perform the flapper alignment procedure and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.

Flapper Alignment

Note

Perform the process indicator zero-and-span calibration procedure and, if necessary, the remote set point calibration procedure before the flapper alignment.

Flapper leveling screw numbers and adjustments are shown in figure 3-1. Provide a means of applying supply pressure to the controller and plug the output connection. After performing the flapper alignment procedure, go to the appropriate startup procedure.

4194HA Proportional-Only Controllers

1. For controllers with manual set point, move the set point adjustment to 50 percent of the process scale range. For controllers with remote set point (suffix letter M), adjust the remote set point pressure until the set point indicator is at 50 percent of the process scale range.
2. Apply differential pressure equal to 50 percent of the process scale range. An alternate method is to disconnect link 1 from the drive arm then manually position the process indicator at 50 percent of the process scale range. Tape the process indicator in place.
3. Remove the screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Adjust the proportional band indicator to between DIRECT and REVERSE.
5. The output of the controller should be:
   - 0.62 ±0.007 bar (9 ±0.1 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output
   - 1.2 ±0.01 bar (18 ±0.2 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output

To adjust controller output, adjust flapper leveling screw 2 (figure 3-1).

6. Adjust the proportional band to 20 percent DIRECT. The output of the controller should remain essentially the same.
   - 0.62 ±0.017 bar (9 ±0.25 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output
   - 1.2 ±0.03 bar (18 ±0.5 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output
7. Adjust the proportional band to 20 percent REVERSE. The output of the controller should remain essentially the same.
   - 0.62 ±0.017 bar (9 ±0.25 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output
   - 1.2 ±0.03 bar (18 ±0.5 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output
8. Repeat steps 4 through 7 until the output of the controller remains in tolerance with no adjustment of the flapper leveling screws.
9. Release the process indicator and connect link 1 to the drive arm.
10. Set the proportional band adjustment to 400 percent in the desired controller action (DIRECT or REVERSE). Replace the proportional band cover.

4194HB Proportional-Plus-Reset and 4194HC Proportional-Plus-Reset-Plus- Rate Controllers

Note

4194HB and HC controllers with the anti-reset windup option (suffix letter F) are supplied with two O-rings (key 52, figure 6-1/CONTROLLER COMMON PARTS), valve cover (key 51, figure 6-1/VIEW E, 4194HB CONTROLLERS or VIEW E, 4194HC CONTROLLERS), and two machine screws (key 53, figure 6-1/VIEW E, 4194HB CONTROLLERS or VIEW E, 4194HC CONTROLLERS). Use these parts in the next step.

1. For 4194HB and HC controllers with the anti-reset windup option (suffix letter F), remove the differential relief valve (key 55, figure 6-1/VIEW E, 4194HB CONTROLLERS, OPTION F or VIEW E, 4194HC CONTROLLERS, OPTION F). Install the two O-rings (key 52) and valve cover (key 51) provided with the controller. Secure the valve cover over the two O-rings with the two machine screws (key 53) also provided.

2. For a controller with manual set point, move the set point adjustment to 50 percent of the scale range. For a controller with remote set point, adjust the remote set point pressure until the set point indicator is at 50 percent of the scale range.
3. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Adjust the reset adjustment to 0.01 minute per repeat.
5. If the controller has rate (4194HC controllers), turn the rate adjustment to OFF.
6. If the controller has the external feedback option (available with 4194HB controllers only), shut off the supply pressure, connect the controller output to the external feedback connection, and turn on the supply pressure. See figure 2-2 for the location of the output and external feedback connections.
7. Adjust the process differential pressure to 50 percent of the input range. If pressure is not available to pressure the differential pressure unit to 50 percent of range, an alternate method is to disconnect link 1 at the drive arm and tape the process indicator at 50 percent of the input range. This method should only be used if pressure is not available to pressure the differential pressure unit to 50 percent.

Note

In steps 8 through 12, the controller output will not stabilize because of the high controller gain. The controller output gauge is adequate to check the output pressure during this procedure.

8. Set the proportional band between DIRECT and REVERSE.
9. Adjust flapper leveling screw number 2 until the controller output is relatively stable at any value within the output range.
10. Adjust the proportional band to 20 percent DIRECT (direct action). Adjust flapper leveling screw number 3 until the controller output is relatively stable at any value within the output range.
11. Adjust the proportional band to 20 percent REVERSE (reverse action). Adjust flapper leveling screw number 1 until the controller output is relatively stable at any value within the output range.
12. Repeat steps 8 through 11 until the controller output remains relatively stable with no adjustments of the flapper leveling screws.

Note

Steps 13 through 19 check the flapper alignment.

13. Adjust the proportional band to 100 percent DIRECT (direct action).
14. Apply pressure to the differential pressure unit or, if link 1 was disconnected, remove the tape from the process indicator and move the indicator until it aligns with the right-hand edge of the set point indicator (as shown in figure 5-1).

    Controller output should be within 0.14 bar (2 psig) of the supply pressure.

15. Pressure the differential pressure unit or, if disconnected, move the process indicator to the left-hand edge of the set point indicator (as shown in figure 5-1).

    Controller output pressure should go to 0 psig.

16. Adjust the proportional band to 100 percent REVERSE (reverse action).
17. Pressure the differential pressure unit or, if disconnected, move the process indicator to align with the right-hand edge of the set point indicator. The controller output should be 0 psig.

18. Pressure the differential pressure unit or, if disconnected, position the process indicator to align with the left-hand edge of the set point indicator. The controller output should be within 0.14 bar (2 psig) of supply pressure.
19. If the controller does not perform as indicated in steps 13 through 18, the flapper is not correctly aligned. This may occur because the output was not sufficiently stabilized in steps 8 through 12. Repeat steps 7 through 18.
20. Set the proportional band to 400 percent in the desired controller action. Replace the proportional band indicator cover (key 36) and install the two machine screws (key 6). If link 1 was disconnected, reconnect link 1 to the drive arm using the same hole connections.
21. If the controller has the external feedback option, disconnect the outside tubing which connects the external feedback connection to the output connection.
22. For 4194HB and HC controllers with the anti-reset windup option (suffix letter F), remove the two machine screws (key 53), valve cover (key 51), and two O-rings (key 52) installed in step 1 of this procedure. Install the differential relief valve (key 55).

Anti-Reset Windup Valve (suffix letter F) Calibration

Calibration for the anti-reset windup valve to relieve on rising controller output pressure:

1. Plug the controller output connection or connect it to a pressure gauge if desired (open-loop conditions must exist).
2. Set the reset adjustment to 0.01 minute per repeat (wide open) and the rate adjustment (4194HC controllers only) to the OFF position.
3. For a controller with manual set point, move the set point to 50 percent of the scale range. For a controller with remote set point, adjust the remote set point pressure until the set point indicator is at 50 percent of the scale range.
4. Adjust the proportional band to 100 percent DIRECT or REVERSE depending on the application requirements.
5. Refer to figure 3-1 or figure 6-1 (VIEW E, SUFFIX BF) for the location of the anti-reset windup valve. For the anti-reset windup valve to relieve on rising controller output pressure, install the valve so the arrow on the valve points down. If you must change the direction of the arrow, loosen the two mounting screws, pull the valve out, and reinstall with the arrow, direction reversed. Tighten the two mounting screws.
6. Turn on the supply pressure to the recommended value shown in table 1-4.

Note

Because of the high controller gain with the reset adjustment at 0.01 minute per repeat, the controller output will not balance perfectly in the following step. If the controller output is stable for approximately 5 seconds, it is adequately balanced.

7. Increase the process differential pressure to the differential pressure unit until the controller output pressure is balanced at 6 psig (for a 3 to 15 psig output range) or 12 psig (for a 6 to 30 psig output range).
8. Turn the reset adjustment to the CLOSED (4194HB controllers) or OFF (4194HC controllers) position.
9. Increase the process differential pressure until controller output pressure changes in small steps (approximately 0.5 psig). After each change in input, the controller output pressure should quickly change and then stabilize at the new value.
10. Continue to affect the controller output pressure in 0.5 psi steps and check the output pressure after each step to make sure that it stabilizes. At some point, the controller output will start to ramp upward to supply pressure with no further change to the differential pressure input. Record the controller output pressure where this ramping action begins because this is the point at which the anti-reset windup valve has relieved.
11. To obtain the anti-reset windup valve differential setting, calculate the difference between the original controller output pressure in step 7 and the controller output pressure recorded in step 10.

12. If the differential pressure calculated in step 11 is incorrect for the application, the differential can be adjusted by turning the anti-reset windup valve adjustment screw (see figure 3-1). Turning the screw clockwise will decrease the differential pressure. Turning the screw counterclockwise will increase the differential pressure. The anti-reset windup valve is set at the Fisher factory at approximately 5 psi differential pressure.
13. Repeat steps 7 through 12 until the required differential pressure is obtained.

Calibration for the anti-reset windup valve to relieve on falling controller output pressure:

1. Plug the controller output connection or connect it to a pressure gauge if desired (open-loop conditions must exist).
2. Set the reset adjustment to 0.01 minute per repeat (wide open) and the rate adjustment (4194HC controllers only) to the OFF position.
3. For a controller with manual set point, move the set point to 50 percent of the scale range. For a controller with remote set point, adjust the remote set point pressure until the set point indicator is at 50 percent of the scale range.
4. Adjust the proportional band to 100 percent DIRECT or REVERSE depending on the application requirements.
5. Refer to figure 3-1 for the location of the anti-reset windup valve. For the anti-reset windup valve to relieve on falling controller output pressure, install the valve so the arrow on the valve points up. If you must change the direction of the arrow, loosen the two mounting screws, pull the valve out, and reinstall with the arrow, direction reversed. Tighten the two mounting screws.
6. Turn on the supply pressure to the recommended value shown in table 1-4.

Note

Because of the high controller gain with the reset adjustment at 0.01 minute per repeat, the controller output will not balance perfectly in the following step. If the controller output is stable for approximately 5 seconds, it is adequately balanced.

7. Increase the process differential pressure input to the differential pressure unit until the controller output pressure balances at 12 psig (for a 3 to 15 psig output range) or 24 psig (for a 6 to 30 psig output range).
8. Turn the reset adjustment to the CLOSED (4194HB controllers) or OFF (4194HC controllers) position.
9. Decrease the differential pressure until controller output pressure changes in small steps (approximately 0.5 psig). After each change in differential pressure input, the controller output pressure should quickly change then stabilize at the new value.
10. Continue to affect the controller output pressure in 0.5 psi steps and check the output pressure after each step to make sure that it stabilizes. At some point, the controller output will start to ramp downward to 0 psig with no further change to the controller input or set point. Record the controller output pressure where this ramping action begins because this is the point at which the anti-reset windup valve has relieved.
11. To obtain the anti-reset windup valve differential setting, calculate the difference between the original controller output pressure in step 7 and the controller output pressure recorded in step 10.
12. If the differential pressure calculated in step 11 is incorrect for the application, the differential can be adjusted by turning the anti-reset windup valve adjustment screw (see figure 3-1). Turning the screw clockwise will decrease the differential pressure. Turning the screw counterclockwise will increase the differential pressure. The anti-reset windup valve is factory set at approximately 5 psi differential pressure.
13. Repeat steps 7 through 12 until the required differential pressure is obtained.

Remote Set Point (suffix letter M) Maintenance

⚠ WARNING

Refer to the Maintenance WARNING at the beginning of this section.

Remote Set Point Assembly Replacement

Use the following procedures to replace the remote set point assembly. Refer to figure 6-3 for key number locations.

Note

Remove the supply pressure gauge before attempting to remove the remote set point capsular element assembly.

1. Decrease the remote set point pressure to 0 psig.
2. Remove the supply pressure gauge.
3. Remove the pressure connection (key 93) at the pedestal assembly (key 105). Use two 5/16-inch wrenches.
4. Disconnect link B (key 126) from the connection hole on the set point adjustment assembly.
5. Remove the three mounting screws (keys 120 and 140) holding the remote set point assembly to the process/set point indicator assembly. See figure 3-2 for the location of the screws.

CAUTION

In the following step, do not lift out the remote set point capsular element assembly by holding the capsule or linkages. These parts may be damaged.

6. Lift out the capsular element assembly by holding the plate (key 111), travel stop (key 83), or pedestal assembly (key 105).
7. Align the replacement assembly with the mounting screw holes. Replace the mounting screws.
8. Reconnect the remote set point pressure connection union (key 93). Apply full remote set point pressure and check for leaks.
9. Connect link B (key 126) to the connecting hole on the set point indicator assembly.
10. Replace the supply pressure gauge.
11. Perform the remote set point maintenance calibration procedure in this section. Also, perform the appropriate controller calibration procedure in Section 3 or 4.

Replacing Remote Set Point Parts

Pivot Assembly A (Key 114)

CAUTION

Avoid bending or kinking the drive flexure during this procedure. Bending or kinking the drive flexure can result in product damage and impaired performance.

1. Decrease the remote set point pressure to 0 psig.
2. Remove the two screws (key 103) from the tie bar (key 106) and remove the tie bar.

3. Note where link A (key 116) is connected. Disconnect the link from the lever arm on the pivot assembly.
4. Disconnect the drive flexure (key 79) from the adjustment arm of the pivot assembly. Be careful not to bend or kink the drive flexure.
5. Remove the screw (key 122), the washer (key 123) and the nut (key 124) holding the guide flexure to the top of the pivot assembly.
6. Remove the pivot screw (key 109) and spring washer (key 112) and the mounting screw (key 102) attaching the pivot assembly to the mounting plate. Lift out the pivot assembly.
7. Loosen the screw (key 118) on the adjustment arm of the replacement pivot assembly and set the arm to the same length as the arm on the pivot assembly being replaced. Tighten the screw.
8. To replace the pivot assembly, first put the spring washer on the screw. Then, install the screw through the pivot assembly into the mounting plate. Install one of the machine screws (key 102) and tighten.
9. Connect the guide flexure (key 119) to the top of the replacement pivot assembly with the machine screw (key 122), washer (key 127), and nut (key 124) as it was before. The guide flexure should be straight and horizontal as shown in figure 3-2. If not, loosen the machine screws (key 122) and retighten to eliminate bowing. Loosen the machine screws (key 139) and raise or lower the pedestal assembly (key 105) to get the link horizontal. Retighten the machine screws (key 139) and ensure the capsular element assembly extension (key 134) is centered in the upper travel stop (key 83) hole.
10. Increase the remote set point pressure to 50 percent of input span.

Note

The adjustment arm of the remote set point pivot assembly turns on a bushing at each end of the shaft supporting the adjustment arm. In the next step, position the shaft so both bushings ”float” inside the bearings and do not rest against the end of either bearing.

11. Connect the drive flexure (key 79) to the arm on the new pivot assembly, making sure it stays straight and vertical. Adjust the length of the pivot arm, if necessary, until the flexure is vertical. Before tightening down the drive flexure (key 79), hold the pivot shaft in the middle of the bushing end play. Be sure neither bushing is resting against the inside end of either bearing. Tighten down the drive flexure to hold pivot assembly A in that position. Do not bend or twist the flexure when tightening the screws.
12. Decrease the remote set point pressure to 0 psig.
13. Connect the end of link A (key 116) in figure 6-3 to the pivot lever arm in the same position noted in step 3.
14. Replace the tie bar (key 106).
15. After replacing parts, refer to the various maintenance calibration procedures (process zero-and-span adjustment, flapper alignment).

Pivot Assembly B (Key 115)

Refer to figure 6-3 for the key number locations.

1. Decrease the remote set point to 0 psig.
2. Note the holes where links A and B are connected. Disconnect links A and B (keys 116 and 126) from the arms of pivot assembly B (key 115).
3. Remove the two machine screws (key 102) attaching pivot assembly B to the mounting plate (key 111). Remove pivot assembly B.
4. Loosen the linearity adjustment screw on replacement pivot assembly B and set it in the same position as the adjustment on original pivot assembly B. Tighten the screw.
5. Set replacement pivot assembly B on the mounting plate and attach it with the two machine screws.

6. Attach links A and B (keys 116 and 126) to the arms of the replacement pivot assembly B in the positions noted in step 2.
7. Perform the remote set point maintenance calibration procedure in this section. Also, perform the appropriate controller calibration procedure in Section 3 or 4.

Drive Flexure

CAUTION

Avoid bending or kinking the drive flexure during this procedure. Bending or kinking the drive flexure can result in product damage and impaired performance.

1. Disconnect the flexure (key 79) from the drive bracket (key 121) and from the adjustment arm of pivot assembly A. Remove the screws and washers (key 12 and 13); remove the flexure.
2. Set remote set point pressure at 50 percent of input span.

Note

The adjustment arm of the pivot assembly turns on a bushing at each end of the shaft supporting the adjustment arm. In the next step, position the shaft so both bushings "float" inside the bearings and do not rest against the end of either bearing.

3. Connect the new flexure making sure it stays straight and horizontal. Before tightening down the drive flexure, set pivot A in the middle of the bushing end play. Tighten down the drive flexure to hold the pivot in that position. Do not kink or twist the flexure when tightening the screws.
4. Decrease the remote set point pressure to 0 psig.
5. After replacing parts, refer to the various maintenance calibration procedures (process zero-and-span adjustment, flapper alignment).

Remote Set Point Tubing

1. Decrease the remote set point pressure to 0 psig.
2. Disconnect the pressure connection (key 93) into the pedestal assembly (key 105) and the connection to the case exterior at the top of the case.
3. Remove the tubing (key 104).
4. Install the replacement tubing and reconnect the two pressure connections.
5. Apply full remote set point pressure and check for leaks.

Link A

1. Note where link A (key 116) is connected (figure 6-3). Disconnect both ends of the link from the lever arms on the two pivots.
2. Loosen the screw in the replacement link and adjust the length to match the link being replaced. Tighten the screw. Refer to figure 6-3 for correct orientation of the link.
3. Attach the replacement link to the two lever arms in the same position as noted in step 1.
4. After replacing parts, refer to the various maintenance calibration procedures (process zero-and-span adjustment, flapper alignment).

Link B

1. Note where link B (key 126) is connected (figure 6-3). Disconnect both ends of the link from the pivot arm and from the set point indicator assembly.
2. Loosen the screw in the replacement link and adjust the length to match the link being replaced. Tighten the screw.
3. Attach both ends of the replacement link. Refer to figure 6-3 for correct orientation of the link and position the link as noted in step 1.
4. After replacing parts, refer to the various maintenance calibration procedures (process zero-and-span adjustment, flapper alignment).

Pressure Control Block for Remote Set Point

1. Remove remote set point pressure.
2. Loosen the nut on that portion of the tubing connecting the capsular element to the pressure control block (key 57).
3. Remove the two cap screws (key 58) holding the pressure control block to the frame (key 3) and lift out the pressure control block.
4. Install the O-ring (key 7) on the replacement pressure control block.
5. Install the replacement pressure control block to the frame with two screws (key 58).
6. Tighten the nut loosened in step 2.
7. Apply the maximum value of remote set point pressure and check for leaks.

Remote Set Point Maintenance Calibration

⚠ WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure, do not exceed the operating limits given in this manual.

Note

Perform all maintenance calibration procedures upon completion of maintenance. If only zero-and-span or linearity adjustments are required, use only those procedures. Key numbers are referenced in figures 6-1 and 6-2. Adjustments are shown in figure 3-1. After maintenance calibration, perform the flapper alignment procedures if directed to do so. Otherwise, go to the appropriate prestartup instructions in the Controller Operation section.

Remote Set Point Precalibration Procedures

1. Set the proportional band adjustment between DIRECT and REVERSE.
2. Remove the tie bar (key 106).
3. Apply 50 percent of full span remote set point pressure.
4. The drive flexure (key 79) should be straight. If not, proceed as follows:
   a. Loosen the screw on the adjustment arm on pivot assembly A (key 114) and the screws holding the drive flexure.
   b. Set the length of the adjustment arm so the drive flexure is parallel to the centerline of the capsules.
   c. Tighten the screw on the adjustment arm.

Note

The adjustment arm of pivot A turns on a bushing at each end of the shaft supporting the adjustment arm. In the next step, position the shaft so both bushings ”float” inside the bearings and do not rest against the end of either bearing.

d. Set pivot A in the middle of the bushing end play.

e. Tighten the screws holding the drive flexure in place.

5. The guide flexure should also be straight. If not, loosen the screw (key 122) on the end of the flexure attached to the top of pivot A (key 114). Allow the flexure to straighten itself. Tighten the screw on the flexure.

Setting Remote Set Point Travel Stops

1. Loosen the set screw (key 87) in the lower travel stop nut (key 86).

CAUTION

Make sure the loose travel stop nut does not bind up on the diaphragm capsule extension when pressurizing the capsules. Damage to the capsules could result.

2. Upper range stop — Adjust the remote set pressure to 2-1/2 percent of span greater than the upper range limit. Loosen the two screws (keys 139 and 140) mounting the travel stop (key 83) to the mounting plate. Slide the travel stop until it is just touching the end of the capsule stack. Tighten the travel stop mounting screws (keys 139 and 140) to lock it into that position.
3. Zero Stop — Adjust the remote set point pressure to 2-1/2 percent of span less than the lower range limit. Slide the travel stop nut (key 86), along the diaphragm assembly extension (key 134) until it is just touching the travel stop (key 83). Tighten the set screw (key 87) to lock the travel stop nut in that position.

Aligning Remote Set Point Linkage

1. Adjust the remote set point pressure to 50 percent of the remote set point range.
2. Set the linearity adjustment screw in the center of the slot on the lever arm of pivot assembly B (key 115). See figure 3-2 for the location of the linearity adjustment.
3. Set the length of link A (key 116) so the lever arms of pivot assembly A and pivot assembly B are parallel and link A is perpendicular to them.
4. Set the length of link B (key 126) so the set point indicator indicates 50 percent of the process scale range.
5. Replace the tie bar (key 106) by installing the two screws (key 103) through the tie bar and into the travel stop and support.

Remote Set Point Zero-and-Span Adjustment

Note

For routine remote set point zero-and-span adjustment, see the appropriate procedure in Section 3 or 4. Use the following maintenance procedures only if difficulty or nonlinearity occurs or if directed by another procedure.

1. Decrease remote set point pressure to the lower range limit.
2. Loosen the adjustment screw on link A (key 116) and adjust the length so the set point indicator points to the lower limit of the process scale. Tighten the screw.
3. Make fine zero adjustments by loosening the zero adjustment locking screw (key 102) and turning the zero adjustment screw (key 108). Tighten the locking screw (key 102). Refer to figure 3-2 for location of the screws.
4. Increase the remote set point pressure to the upper range limit.
5. To increase the span, proceed as follows:
   a. Turn the span adjustment screw clockwise.
   b. To increase the span further than the adjustment allows, move both ends of link A (key 116) to the right.
   c. Make fine adjustments with the span adjustment screw.
6. To decrease the span, proceed as follows:
   a. Turn the span adjustment screw counterclockwise.
   b. To decrease the span further than the adjustment allows, move both ends of link A (key 116) to the left.
   c. Make fine adjustments with the span adjustment screw.
7. Repeat the adjustments until the upper and lower indications are aligned with the 0 and 100 percent markings on the process scale.
8. Adjust the remote set point pressure to 50 percent of the remote set point range.
9. The remote set point indicator should be accurate to within ±2 percent of the process scale span. If the accuracy is outside ±2 percent of the process scale span, proceed to the following linearity adjustment procedure.
10. Adjust the set point indicator to 50 ±1 percent of the process scale range by loosening the zero adjustment locking screw and turning the zero adjustment screw. Tighten the locking screw.
11. Adjust the remote set point pressure to the upper and lower limits of the remote set point range and make sure the set point indicator is still within ±1 percent at the 0 percent and at the 100 percent process scale marks.
12. Perform the appropriate flapper alignment procedure and, if necessary, the process pointer zero-and-span calibration procedure in Section 3 or 4.

Remote Set Point Linearity Adjustment

Adjust the linearity by loosening and repositioning the linearity adjustment screw in the curved slot on the lever arm of pivot assembly B (key 115). Adjusting the linearity affects the zero-and-span adjustment.

1. Adjust the remote set point pressure to 50 percent of the remote set point range. The set point indicator should indicate the 50 ±1 percent mark on the scale. If not, make fine adjustments by loosening the zero adjustment locking screw and turning the zero adjustment screw.
2. Adjust the remote set point pressure to 0 percent and note the indicator position relative to the process scale 0 percent marking.
3. Adjust the remote set point pressure to 100 percent and note the indicator position relative to the process scale 100 percent marking.
4. If the greatest misalignment is positive (the set point indicator is to the right of the process scale markings), loosen the linearity screw and move it clockwise in the slot. If the misalignment is negative, move the linearity screw counterclockwise in the slot.
5. If misalignment is greater than 1 percent of the process scale span at the 0 and 100 percent markings, with one positive and the other negative, perform the remote set point zero-and-span adjustment procedure to correct a span error.

6. Repeat steps 1 through 4 until lower, middle, and upper indications are within ±1 percent of the process scale markings.

Replacing Auto/Manual Station (suffix letter E) Parts

Disassembly of the Auto/Manual Station

Note

This procedure also permits replacement of the switch manifold O-rings (key 312), the auto/manual tubing assembly (key 138), and the frame gaskets (keys 4 and 5).

Note

Before starting the following procedure, remove the controller from the case. Perform steps 1 through 7 of the Replacing the Differential Pressure Unit procedure. Then, perform steps 1 and 2 of the Replacing the Case and Cover procedure.

Refer to figures 6-5 and 6-4 for key number location.

1. Perform the procedures referenced in the note above.
2. Loosen the screw (key 316) holding the auto/manual station (key 273) to the controller frame.
3. Loosen the two screws (keys 314 and 315) holding the auto/manual station to the auto/manual tubing assembly (key 138).
4. Remove the auto/manual station from the controller frame.
5. Remove the switch manifold O-rings (key 312).
6. Carefully loosen the nut on the relay nozzle tubing assembly (key 18, figure 6-1) where it connects to the auto/manual tubing assembly (key 138). Loosen three screws (keys 34 and 131) and remove the tubing assembly and body gaskets (keys 4 and 5).
7. Inspect the gaskets (keys 4 and 5) and O-rings (key 312) for wear. Replace if necessary.

Assembly of the Auto/Manual Station

1. Install the gaskets and the tubing assembly to the frame. Start, but do not tighten, the three screws (keys 34 and 131) and the nut on the nozzle tubing assembly (key 18).
2. Install the three O-rings (key 312) and secure the auto/manual station to the controller frame with the screw (key 316) and to the tubing assembly (key 138) with two screws (keys 314 and 315). Do not tighten any screws.

CAUTION

In the next step, take care to tighten the two screws (keys 314 and 315) evenly. Uneven tightening could damage the tubing assembly.

3. Position the auto/manual station as far down on the frame and toward the scale as possible. Carefully tighten the two screws (keys 314 and 315) so the auto/manual station contacts the three pads on the tubing assembly.
4. Carefully tighten the remaining screws and nuts.

5. Apply air pressure to the controller and check for leaks.
6. Install the controller assembly in the case. Slide the controller frame down to assure an O-ring seal at the pressure connections. Hold the frame in place.
7. Install and tighten the nine screws holding the controller assembly in the case.
8. Refer to the flapper alignment procedure.

Replacing the Auto/Manual Station Switch Body Assembly, Lever O-Ring, Switch Body O-Ring, and the Tubing Assembly

Refer to figure 6-5 for key number location.

Disassembly

1. Remove the auto/manual station from the controller frame as described in steps 1 through 4 of the procedure for replacing the auto/manual station.
2. Loosen the two screws (key 288) and remove the lever cover plate (key 305).

CAUTION

The lever spring (key 302) is under preload. Take care not to lose any parts during disassembly.

3. Using a 1.5 mm (1/16-inch) punch, push the groove pin (key 303) out toward the surface of the lever cover plate.
4. Remove the switch lever (key 304), lever spring (key 302), and lever spring seat (key 301).
5. Remove the tubing assembly (key 309).

CAUTION

The switch body springs (key 295) are under preload. Take care not to lose any parts when separating the switch body assembly from the loader assembly.

6. Loosen the two screws (key 290) and separate the switch body assembly (key 291) from the loader assembly (key 282).
7. Remove the O-rings (keys 292, 293, and 294), switch body springs (key 295), and balls (key 296).
8. Loosen two screws (key 308). Remove the closing plate (key 307) and the closing plate gasket (key 306).
9. Pull the clip (key 300) from its engagement with the shaft of the lever assembly (key 297).
10. Pull the lever assembly from the switch body assembly (key 291) and rocker (key 299).
11. Remove the O-ring (key 298).
12. Inspect the O-rings and the gaskets for damage or wear and replace if necessary.

Assembly

1. Insert the lever assembly (key 297) into the switch body assembly (key 291) and hold the rocker (key 299) with the flats on the lever assembly shaft.
2. Insert the clip (key 300) in the groove of the lever assembly shaft to hold the lever assembly (key 297) in the switch body assembly (key 291).

Note

Before assembly in step 3, be sure the side of the closing plate marked OUT is visible.

3. Position the closing plate gasket (key 306) and the closing plate (key 307). Secure with two screws (key 308).
4. Place the balls (key 296), switch body springs (key 295), and O-rings (keys 292, 293, and 294) in the switch body (key 291).

Note

In the following step, the ends of the springs must be in the counterbored spring seats before compression.

5. Compress the switch body springs with the loader assembly (key 282) and bolt the switch (key 291) to the loader assembly using the two screws (key 290).
6. Reconnect the tubing assembly (key 309).
7. Locate the lever spring (key 302) and the spring seat (key 301) on the switch lever (key 304) and position these parts in the opening of the loader assembly (key 282).
8. Push the switch lever down, using the lever spring seat (key 301) and the lever assembly (key 297) to preload the spring. Make sure the notch of the switch lever engages the pin of the lever assembly.
9. Drive in the groove pin (key 303) to hold the switch lever.
10. Replace the lever cover plate (key 305) and attach with two screws (key 288).
11. Perform the assembly portion of the replacing the auto/manual station procedure.

Replacing the Auto/Manual Station Switch Range Spring, Diaphragm Assembly, Ball Seat, Tubing, and Ball

Refer to figure 6-5 for key number location.

Disassembly

1. Remove the auto/manual station from the controller frame as described in steps 1 through 4 of the procedure for replacing the auto/manual station.
2. Remove tubing assembly (key 309).

⚠ WARNING

To avoid personal injury caused by preload from the range spring (key 282), turn the loader knob (key 287) counterclockwise (opposite to the arrow) to relieve pressure on the spring.

3. Loosen the four screws (key 289) and separate the loader assembly (key 282) and the lower loader assembly (key 274).
4. Remove the loader range spring (key 283), range spring cup (key 284), and diaphragm assembly (key 281).
5. Remove the tube (key 278), ball seats (key 280), and ball (key 279).

Assembly

1. Turn the loader knob (key 287) counterclockwise to back the spring adjusting screw (key 285) all the way out to eliminate loading the range spring.
2. Position the range spring cup (key 284), the range spring (key 283), and the diaphragm assembly (key 281) on the loader assembly (key 282).

3. Position the ball (key 279), the tube (key 278), and the ball seats (key 280) between the ears of the loader assemblies (keys 282 and 274); position the diaphragm assembly (key 281) between the main halves of the loader assemblies.

Note

The tube (key 278) must be well-seated in the cups of the ball seats (key 280).

4. Bolt the loader assembly halves together using the four screws (key 289).

Note

Be sure the supply and exhaust seats of the loader are correctly aligned. Misalignment will impair loader performance.

5. Attach the tubing assembly (key 309).
6. Perform the assembly portion in the replacing the auto/manual station procedure.

Replacing the Auto/Manual Station Loader Valve Plug and Valve Plug Spring

Refer to figure 6-5 for key number location.

1. Loosen the spring seat screw (key 275).
2. Remove the valve plug spring (key 276) and the valve plug (key 277).
3. Inspect the parts and replace as necessary.
4. Install the valve plug spring and valve plug.
5. Tighten the spring seat screw.
6. Temporarily apply supply pressure and process differential pressure and check for leaks.
7. Install the controller assembly in the case. Slide the controller frame down to assure an O-ring seal at the pressure connections. Hold the frame in place.
8. Install and tighten the nine screws holding the controller assembly in the case.

Section 6

Parts

Parts Ordering

Whenever corresponding with your Emerson Process Management sales office about this equipment, always mention the controller serial number. When ordering replacement parts, refer to the 11-character part number of each required part number as found in the following part list.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management, should not, under any circumstances, be use in any Fisher instrument. Use of components not supplied by Emerson Process Management may void your warranty, might adversely affect the performance of the instrument, and could result in personal injury and property damage.

Parts Kits

Key	Description	Part Number
	4190 Controller Auto/Manual Repair Kit Contains keys 277, 278, 279, 281, 292, 293, 294, 298, 306, 312	R4190X0AM12
	4190 Controller Auto/Manual Retrofit Kit Contains keys 138, 273, 312, 313, 314, 315, 316 SST tubing	R4190X00S12
	4190 Controller Case Handle Kit Contains lever and mounting hardware	R4190X00H12
	4190 Controller Repair Kit Contains keys 4, 5, 7, 8, 24, 52	R4190X00C12
	4190 Controller Pointer and Bracket Repair Kit Contains pointer and bracket ass'y, 3 machine screws, 3 washers	R4190X00P12
	4194HBF and 4194HCF Anti-Reset Windup Retrofit Kits Contains keys 44, 55 Brass tubing 4194HBF	R4190X00B22
	SST tubing 4194HBF	R4190X00S22

Parts List

Abbreviations Used In Parts List

adj:	adjustment
ass'y:	assembly
fdback:	feedback
fill hd:	fillister head (as in fillister head cap screw)
ext:	external
hd:	head (as in machine screw head)
int:	internal
OD:	outside diameter
pl:	plated (as in plated steel)
pt:	point (as in set point)
qty:	quantity
SST:	stainless steel
w/:	with
w/o:	without

Controller Parts (figure 6-1)

Key	Description	Part Number

Note
Figure 6-1 shows key numbers for the common construction of all controller types. Figure 6-1 continues over several pages. Be sure to check all pages of figure 6-1 to find the common key numbers.

Key	Description	Part Number

Note

Part numbers are shown for recommended spares only. For part numbers not shown, contact your Emerson Process Management sales office.

Key	Description	Part Number
1	Case and cover ass'y For use w/ or w/o int set pt and w/o remote or ext set pt For use w/remote set pt and w/o int or ext set pt	
2	Nameplate, A91100 (aluminum)	
3	Frame, A03600 (aluminum)	
4*	Gasket, chloroprene for use between internal frame and frame manifold (key 135)	18A0749X012
5*	Gasket, chloroprene for use between frame manifold (key 135) and positive feedback tubing manifold (key 136)	18A0742X012
6	Machine screw, fill hd, 18-8 SST (6 req'd)	
7*	O-Ring, nitrile For all types w/either 1/4-18 NPT internal process connection or 1/2-14 NPT external process connection w/o remote set pt (1 req'd) w/remote set pt (2 req'd) w/ext fdback and w/o remote set pt (2 req'd) w/ext fdback and w/remote set pt (3 req'd)	1C376206992
8*	O-Ring, nitrile (3 req'd)	16A6903X012
9	Flexure pivot ass'y, sapphire/SST	
10	Machine screw, fill hd, 18-8 SST (4 req'd)	
11*	Flapper ass'y	29A9518X012
12	Cap screw, hex socket, 18-8 SST For flapper ass'y (key 11) (1 req'd) Plain washer (key 13) not req'd	
17	Adjustable set pt pivot ass'y, SST	
18	Relay nozzle tubing ass'y, SST	
19	Machine screw, fill hd, 18-8 SST (3 req'd)	
20	Plain washer, carbon steel-pl (2 req'd)	
21	Nozzle ass'y, SST	
22	Washer, plastic (2 req'd)	
23	Set pt beam ass'y, aluminum/SST	
25	Proportional band knob, polycarbonate	
26	Retaining clip, S30200 (302 SST)	
27	E-ring, SST	
28	Set pt beam bias spring, pl steel	
29	Set pt beam shoe, G10100 (pl steel)	
30	Machine screw, 18-8 SST (2 req'd)	
31	Bellows bracket, A95052 (aluminum)	
32	Bellows adj bracket, G10100 (pl steel)	
33	Bellows adj spring, pl steel	
34	Machine screw, fill hd, 18-8 SST (2 req'd)	
35	Machine screw, hex hd, 18-8 SST (2 req'd)	
36	Proportional band indicator cover, ABS w/polyester label	
37	Self-tapping screw, 18-8 SST For indicator ass'y (key 101) (4 req'd)	
38	Self-tapping screw, 18-8 SST (9 req'd)	
39	Supply gauge tubing ass'y, SST	
40	Proportional tubing ass'y, SST For 4194HA or HB controllers For 4194HC controllers	
41	Plug, S30300 (303 SST) For all 4194HA controllers (1 req'd) For all 4194HB controllers w/ext feedback (1 req'd) **except** for 4194HBF, HBFM, HBFE, and KBFME, not required For 4194HC, HCM, HCE, and CME (2 req'd) For 4194HCF, HCFM, HCFE, and HCFME (1 req'd)	
42	Reset valve tubing ass'y, SST For all 4194HB controllers	
43	Reset tubing ass'y, SST For all 4194HB controllers For all 4194HC controllers	
44	Relief valve tubing ass'y, SST For 4194HBF, HBFE, HBFM, and HBFME only For 4194HCF, HCFE, HCFM, and HCFME only	

Note

One type of pressure gauge is used for both output pressure and supply pressure indication. See Key 46/47 table for part numbers.

Key	Description	Part Number
46*	Output pressure gauge	See Key 46/47 table
47*	Supply pressure gauge	See Key 46/47 table
48*	Bellows ass'y (2 req'd) Output ranges: 0.2 to 1.0 bar (3 to 15 psig) 0.4 to 2.0 bar (6 to 30 psig) Brass SST	 16A6953X012 16A6953X022
49	Bellows beam, A96061 (aluminum) 0.2 to 1.0 bar (3 to 15 psig) 0.4 to 2.0 bar (6 to 30 psig)	
50	Relay ass'y Relay, 0.2 to 1.0 bar (3 to 15 psig) Relay, 0.4 to 2.0 bar (6 to 30 psig)	

*Recommended spare parts

Key 46/47 Pressure Gauge(1)

RANGE	GAUGE MATERIAL	
	Brass	SST
Dual Scale Gauge		
0 to 30 psig/ 0 to 2 kg/cm^2	11B8577X042	11B8583X032
0 to 60 psig/ 0 to 4 kg/cm^2	11B8577X052	- - -
Triple Scale Gauge		
0 to 30 psig/ 0 to 200 kpa/ 0 to 2 bar	11B8577X012	11B8583X012
0 to 60 psig/ 0 to 400 kpa/ 0 to 4 bar	11B8577X022	11B858X022

1. One type of pressure gauge is used for both output pressure and supply pressure indication.

Key Description Part Number

Note
Keys 51, 52, and 53 are required for all controller types. These parts are included separately with controllers with the anti-reset windup option (suffix letter F).
These parts must be used when removing the differential relief valve (key 55) to perform the flapper alignment procedure for 4194HB and HC controllers.

51 Relief valve cover plate, A03600 (aluminum)
52* O-ring, nitrile (2 req'd) 1C853806992
53 Machine screw, fill hd, 18-8 SST
For 4194HA and HB controllers (2 req'd)
For 4194HC controllers (5 req'd)
54 Reset restriction valve
For 4194HB controllers
55 Differential relief valve
For all 4194H controllers w/suffix letter F, anti-reset windup option

56 Process and set pt indicator ass'y

Note
The part numbers listed below are for the complete process and set pt indicator ass'y. The complete process and set pt indicator ass'y includes the indicator ass'y (key 101) and parts such as the support bracket (key 319) and the pivot bracket ass'y (key 320). Individual indicator ass'y parts are listed in two subsections of this parts list: the Process and Set Point Indicator Assembly (key 56) subsection and the Indicator Assembly (key 101) subsection. Key numbers for individual indicator parts also appear in figure 6-2.

Process and set pt indicator ass'y
plastic/aluminum/stainless steel
w/o remote set (for 4194HS and 4194HSE)
w/remote set (for 4194HSM and 4194HSME)

Key Description

57 Pressure control block, CF8M (316 SST Casting)
1 req'd for remote set pt
1 req'd for ext fdback
58 Cap screw, hex hd, SST
(Maximum qty req'd: 6)

61 Process scale, aluminum
For indicator ass'y
0-5 psid
0-10 psid
0-15 psid
0-20 psid
0-30 psid
0-40 psid
0-50 psid
0-60 psid
0-75 psid
0-250 mbar differential
0-0.6 bar differential
0-1.4 bar differential
0-1.6 bar differential
0-2.0 bar differential
0-20 in. w.c. differential
0-25 in. w.c. differential
0-50 in. w.c. differential
0-75 in. w.c. differential
0-100 in. w.c. differential
0-100 percent
0-10 square root
0-100 square root

62 Remote set pt ass'y (suffix letter M)

Note
The part numbers listed for key 62 are for the complete remote set point (suffix letter M) assembly. Individual assembly parts are listed in the Remote Set Point Assembly subsection of the parts list. Key numbers for individual assembly parts also appear in figure 6-3.

Remote set pt ass'y (suffix letter M)
N09902
0.8 bar (12 psig) span
1.7 bar (24 psig) span
SST
0.8 bar (12 psig) span
1.7 bar (24 psig) span

64 Machine screw, fill hd, 8-8 SST (4 req'd)
65 Feedback link ass'y, aluminum/brass/SST
71 Machine screw, fill hd, 18-8 SST
For 4194HA, HB controllers (4 req'd)
For 4194HC controllers (2 req'd)
72 Blowout plug, silicone

*Recommended spare parts

Key	Description	Part Number
101	Indicator ass'y	

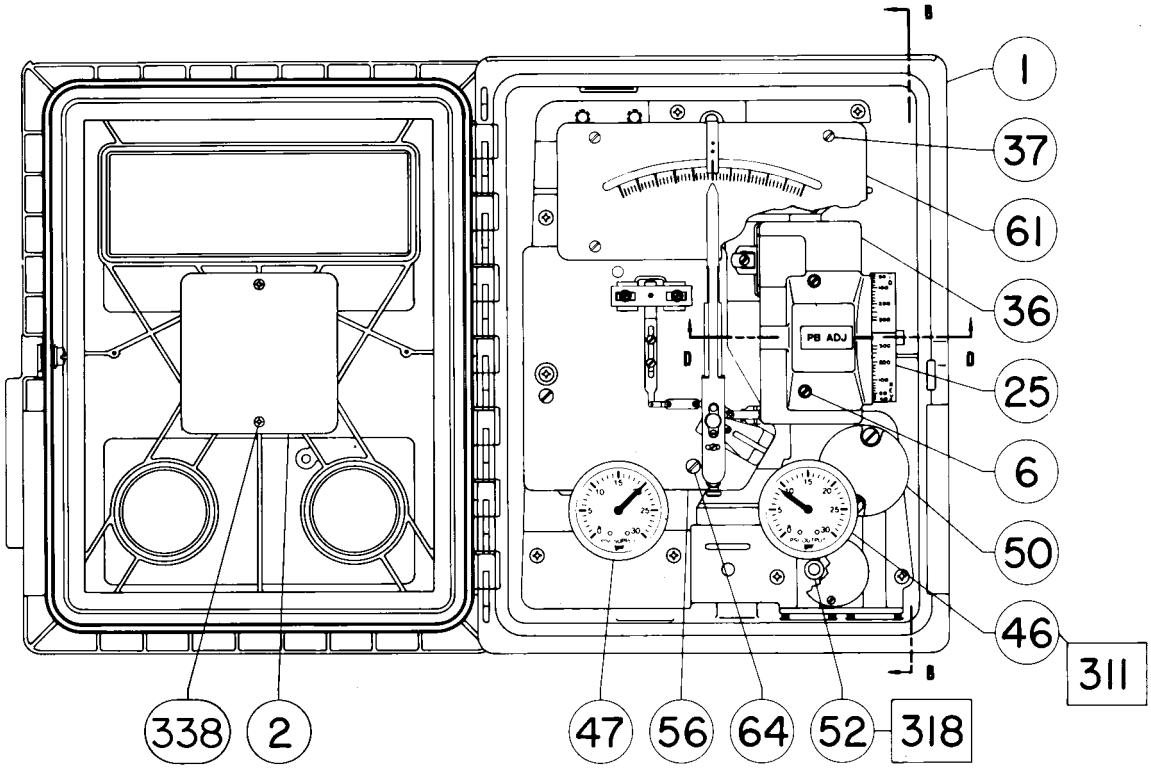
Note

The part numbers listed here for key 101 are for the complete indicator ass'y. Individual assembly parts are listed in the Indicator Assembly (key 101) subsection of the parts list. Key numbers for individual assembly parts also appear in figure 6-4.

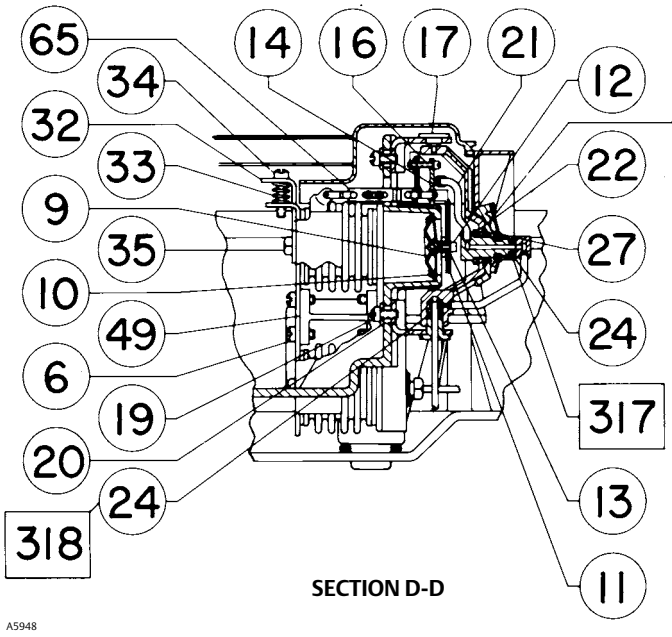
	For use w/o remote set pt	
	For use w/remote set pt	
120	Machine screw, fill hd, 18-8 SST Required to mount remote set pt ass'y (suffix letter M) to indicator ass'y (2 req'd)	
135	Frame manifold, A03600 (aluminum) For all types **except** w/suffix letter E, int auto/man station option	
136	Rate/reset manifold, A03600 (aluminum) For all types **except** 4194HC controllers (rate/reset valve)	
137	Rate tubing ass'y, SST For 4194HC controllers only	
138	Auto/manual tubing ass'y, SST/aluminum Use w/suffix letter E, int auto/manual station option, only	
140	Machine screw, fill hd, 18-8 SST Required to mount the remote set pt ass'y (suffix letter M) to indicator ass'y (2 req'd)	
162	Machine screw, hex hd, 18-8 SST For 4194HB, HC controllers only	
163	Knob, plastic For 4194HB controllers, reset restriction valve (key 54) For 4194HC controllers, rate/reset valve ass'y (key 262) (2 req'd)	
171*	0-Ring, nitrile For 4194HB controllers (2 req'd) For 4194HC controllers (4 req'd)	1H292606992
251	Reset body, Z33520 (zinc die casting) For 4194HB controllers only	
252	Valve plate For 4194HB controllers (1 req'd) For 4194HC controllers (2 req'd)	
253	Scratch Valve, S30300 (303 SST) For 4194HB controllers	
253	Reset Scratch Valve, S30300 (303 SST) For 4194HC controllers	
258	Plain washer, plastic For 4194HB controllers (1 req'd) For 4194HC controllers (4 req'd)	
262	Rate/reset valve ass'y For 4194HC controllers only Brass bellows 0.2 to 1.0 bar (3 to 15 psig) 0.4 to 2.0 bar (6 to 30 psig) SST bellows 0.2 to 1.0 bar (3 to 15 psig) 0.4 to 2.0 bar (6 to 30 psig)	
264	Set screw, hex socket, S30300 (303 SST) For 4194HC controllers only (2 req'd)	
265	Rate Scratch Valve, S30300 (303 SST) For 4194HC controllers only	
266	Cover Plate, steel For 4194HC controllers only	
268	Spring washer, pl steel For 4194HC controllers only (2 req'd)	
269	Spring For 4194HC controllers only (1 req'd)	
270*	Bellows base gasket, chloroprene For 4194HC controllers only (1 req'd)	28A0741X012
271*	Bellows ass'y For 4194HC controllers only Brass bellows 0.2 to 1.0 bar (3 to 15 psig) and 0.4 to 2.0 bar (6 to 30 psig) SST bellows 0.2 to 1.0 bar (3 to 15 psig) and 0.4 to 2.0 bar (6 to 30 psig)	 18A0738X012 18A0738X022
272	Rate/Reset Body, Z33520 (zinc die casting) For 4194HC controllers only	
310	Lithium grease (not furnished with controller)	
311	Anti-seize sealant (not furnished with controller)	
317	Silicone-based lubricant (not furnished with controller)	
318	Lubricant, silicone (not furnished with controller)	
337	Barton 199 Differential Pressure Unit Key 337 includes the pipestand mounting bracket and three set screws (square hd, steel, 3/8-16 x 5/8-inch)	
339	External feedback ass'y, SST tubing	
357	Spring washer, S17700 (17-7PH/HT SST) For 4194HB controllers only	
358	Retainer, 18-8 SST For 4194HB controllers only	
359	Machine Screw, pan hd, 18-8 SST For 4194HB controllers only (3 req'd)	
360	Shoulder Screw, slotted, 18-8 SST For 4194HB controllers only	
361	Lubricant, 20W/50 Motor Oil For 4194HB controllers only	
362	Spring retaining washer, SST	
364	Shim, plastic For 4194HB controllers only	
365	Washer, 18-8 SST	

*Recommended spare parts

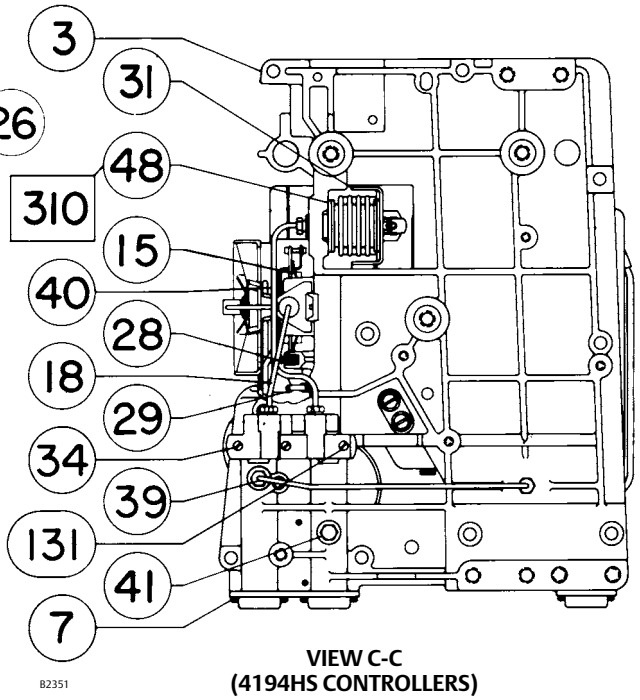
Figure 6-1. Controller Assembly Drawings



CONTROLLER COMMON PARTS



SECTION D-D



VIEW C-C
(4194HS CONTROLLERS)

Figure 6-1. Controller Assembly Drawings (Continued)

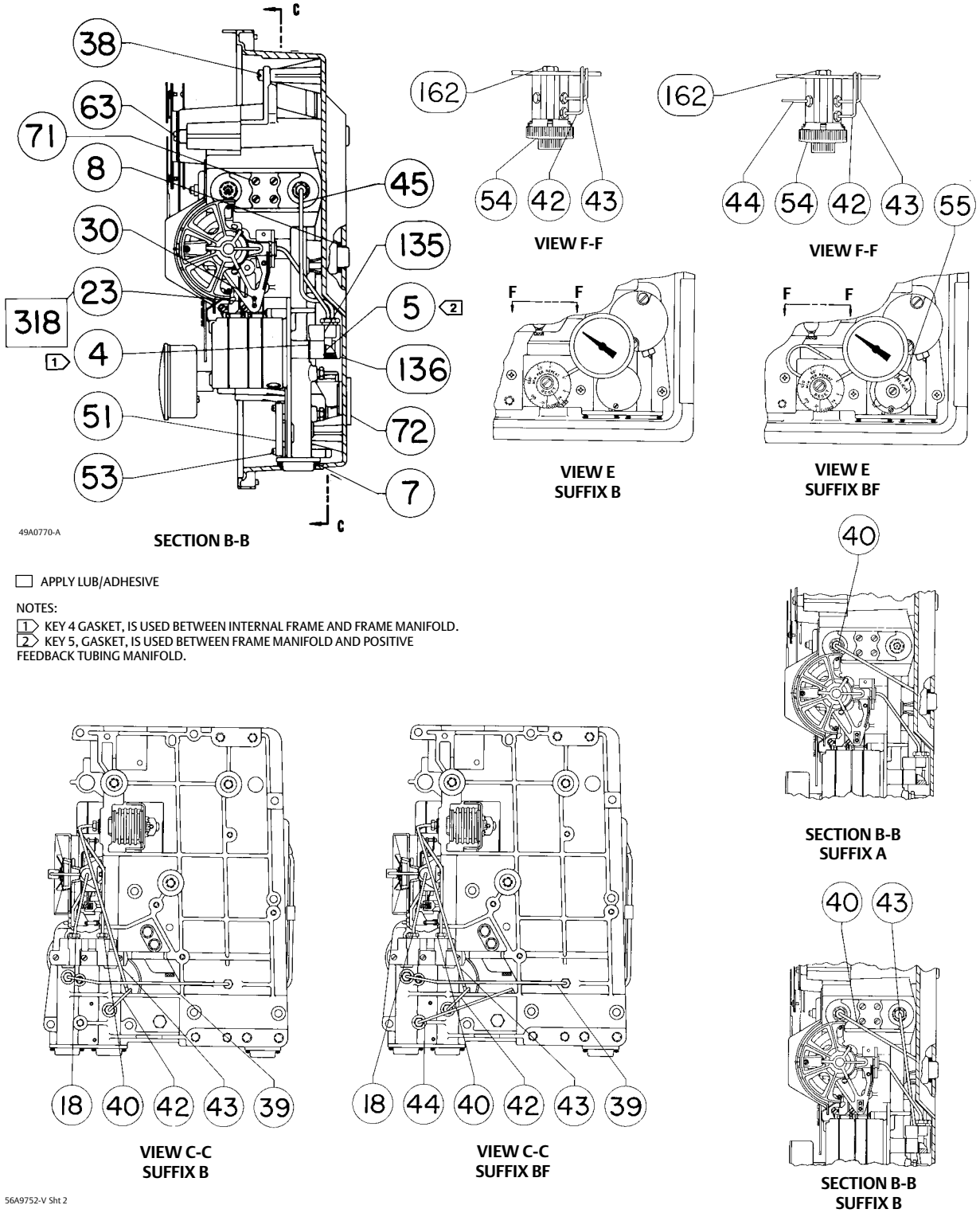
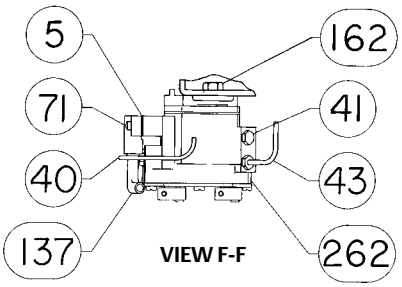
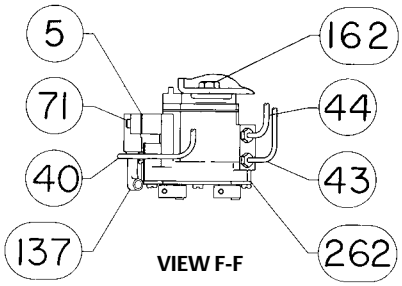


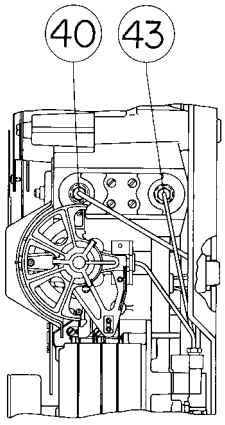
Figure 6-1. Controller Assembly Drawings (Continued)



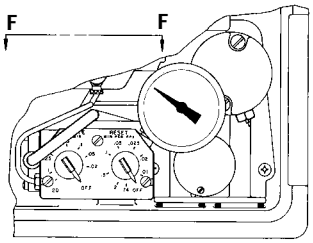
VIEW F-F



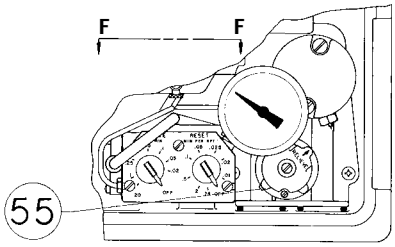
VIEW F-F



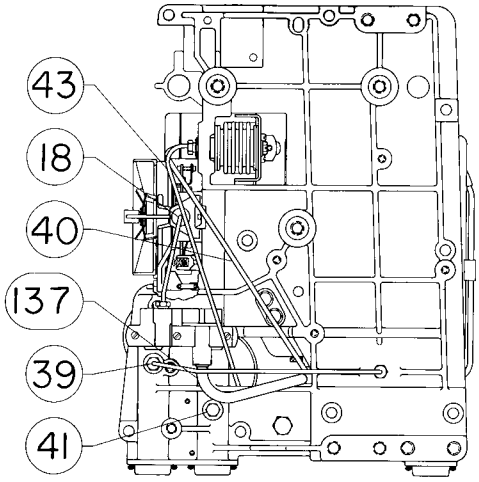
SECTION B-B
SUFFIX C, CF



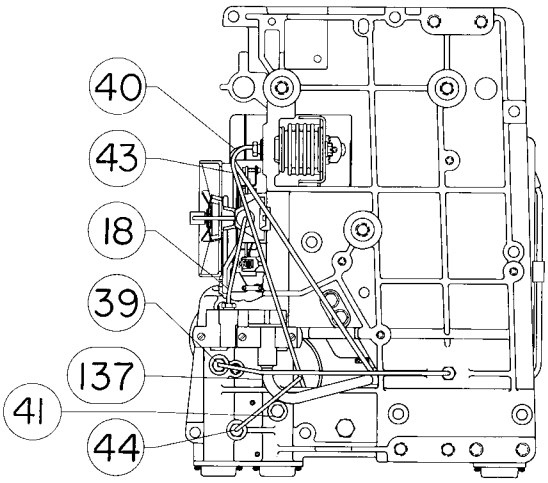
VIEW E
SUFFIX C



VIEW E
SUFFIX CF



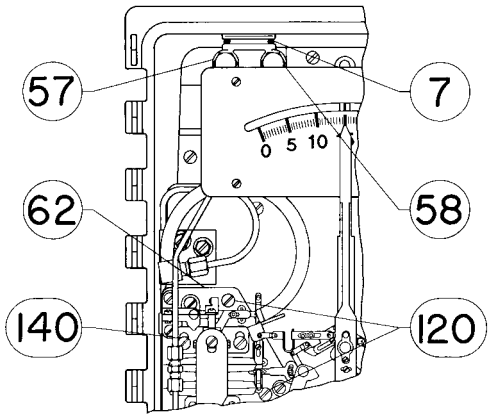
VIEW C-C
SUFFIX C



VIEW C-C
SUFFIX CF

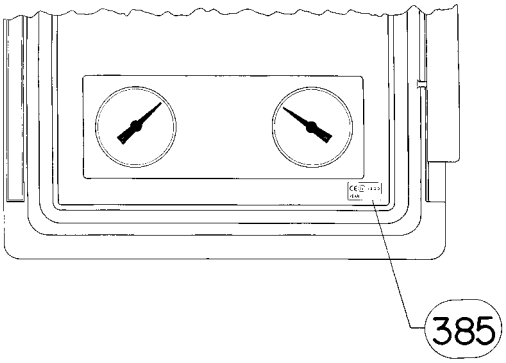
56A9752-V Sht 3

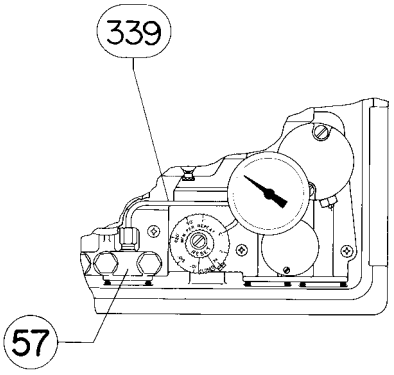
Figure 6-1. Controller Assembly Drawings (Continued)



56A9752-V Sht 4

VIEW H
SUFFIX M

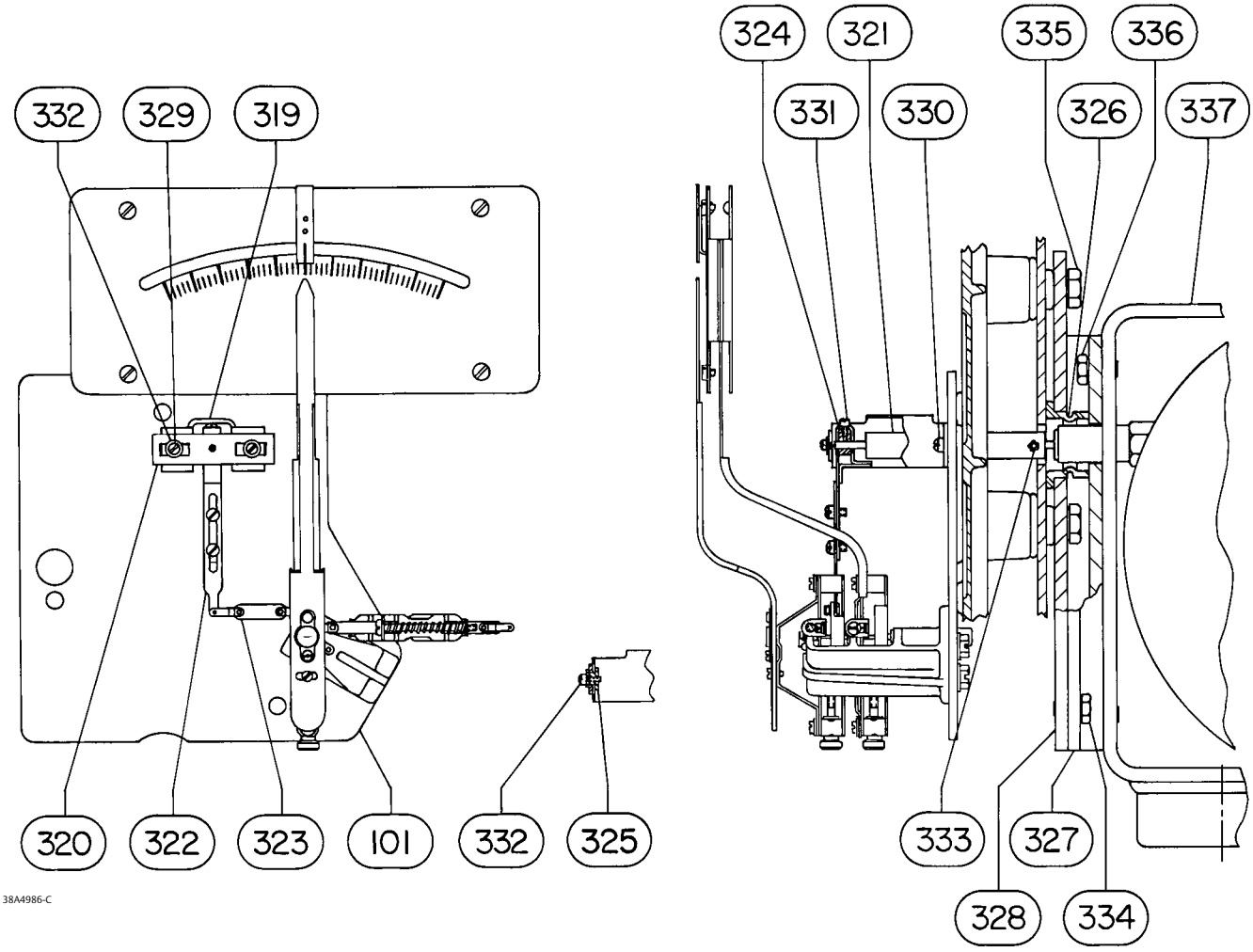




56A9752-V Sht 5

VIEW M
EXTERNAL FEEDBACK ASSY

Figure 6-2. Process and Set Point Indicator Assembly with Differential Pressure Unit

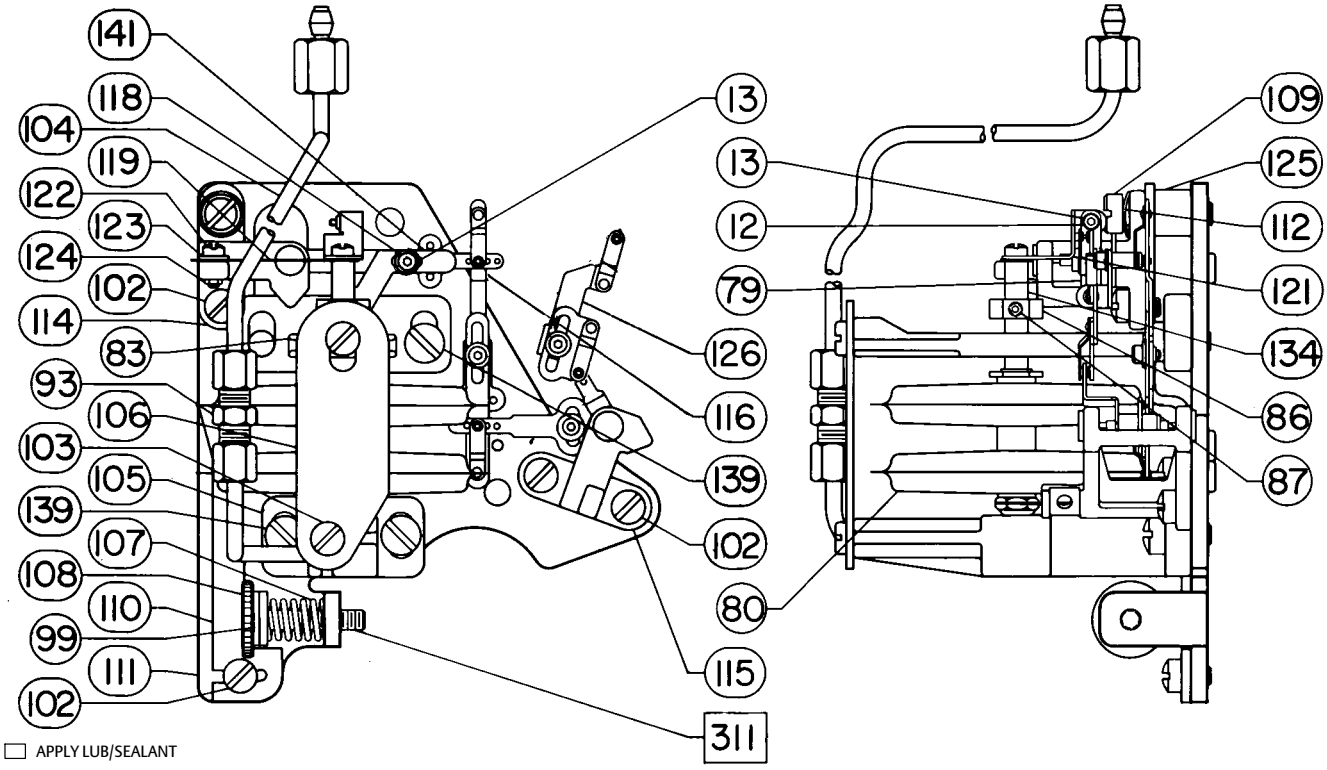


Process and Set Point Indicator Assembly (key 56) (figure 6-2)

Key	Description	Part Number
101	Indicator ass'y	
	For use w/o remote set pt	
	For use w/remote set pt	
319	Support bracket, 18-8 SST	
320	Pivot bracket ass'y, SST/Sapphire	
321	Shaft extension, 18-8 SST	
322	Drive arm ass'y, SST steel	
323	Zero link ass'y, SST/brass	
324	Clamp block, 18-8 SST	
325	Nut (2 req'd)	
326*	Boot, nitrile	18A4999X012
327	Mounting plate (for differential pressure unit), stl zn pl	
328	Controller mounting plate, stl zn pl	
329	Machine screw, pan hd, 18-8 SST (2 req'd)	
330	Machine screw, fill hd, 18-8 SST (2 req'd)	
331	Machine screw, fill hd, 18-8 SST	
332	Plain washer, 18-8 SST (2 req'd)	
333	Set screw, hex socket, 18-8 SST (2 req'd)	
334	Cap screw, hex hd, 18-8 SST (4 req'd)	
335	Cap screw, hex hd, SST (3 req'd)	
336	Cap screw, hex hd, 18-8 SST (4 req'd)	

*Recommended spare parts

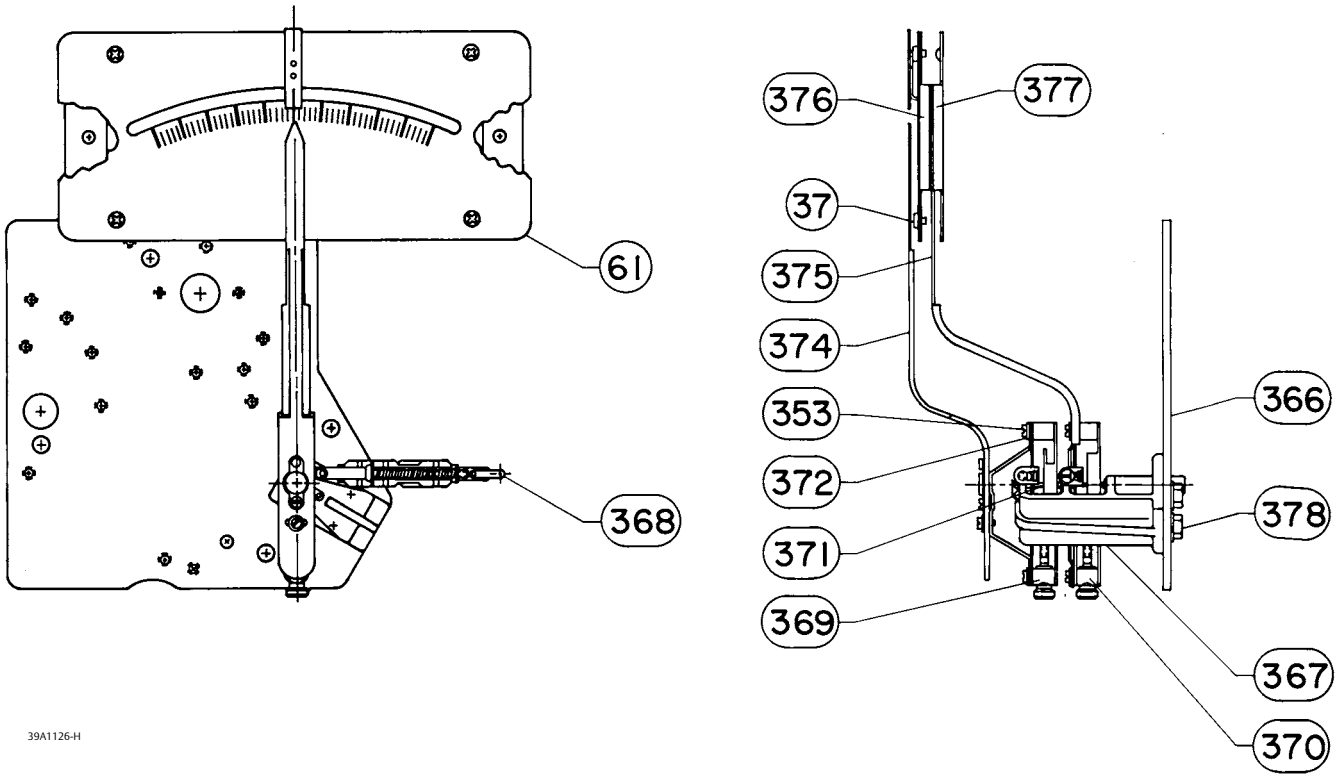
Figure 6-3. Remote Set Point Assembly



Remote Set Point Assembly (key 62) (figure 6-3)

Key	Description
12	Cap screw, hex socket, 18-8 SST (2 req'd)
13	Plain washer, 18-8 SST (3 req'd)
79	Drive flexure, SST
80	Diaphragm capsule ass'y (for 4194HAM, HAME, HBRM, HBFME, HBM, and HBME) 1 req'd for use in remote set pt ass'y (key 62) N09902 0.8 bar (12 psig) span 1.7 bar (24 psig) span SST 0.8 bar (12 psig) span 1.7 bar (24 psig) span
83	Travel stop, CF8 (SST casting)
86	Travel stop nut, S30300 (303 SST)
87	Set screw, hex socket, 18-8 SST
93	Union, S31600 (316 SST)
99	Plain washer, 18-8 SST
102	Machine screw, pan hd, 18-8 SST (4 req'd)
103	Machine screw, pan hd, 18-8 SST (2 req'd)
104	Remote set pt tubing ass'y, S30400 (304 SST)
105	Pedestal ass'y, SST
106	Tie bar, G10100 (pl steel)
107	Spring, pl steel
108	Zero adj screw, S30300 (303 SST)
109	Pivot screw, S30300 (303 SST)
110	Zero adj bracket, S30400 (304 SST)
111	Mounting plate, G10100 (pl steel)
112	Spring washer, pl steel
114	Pivot clevis ass'y A, plastic/SST
115	Pivot clevis ass'y B, plastic/SST
116	Connecting link ass'y, aluminum/bronze/brass
118	Cap screw, hex socket, 18-8 SST
119	Guide flexure, S30200 (302 SST)
121	Drive bracket, S30400 (304 SST)
122	Machine screw, fill hd, 18-8 SST (2 req'd)
123	Plain washer, 18-8 SST
124	Nut, Hex, 18-8 SST
125	Spacer, A92011 (aluminum)
126	Connecting link ass'y, aluminum/bronze/brass
134	Diaphragm ass'y extension, A92011 (aluminum)
139	Machine screw, fill hd, 18-8 SST (3 req'd)
141	Adj arm, S30400 (304 SST)
311	Anti-seize sealant (not furnished with controller)

Figure 6-4. Process and Set Point Indicator Assembly (Manual Set Point)



Indicator Assembly (key 101) (figure 6-4)

Key	Description
37	Self-tapping screw, 18-8 SST (4 req'd)
61	Process scale, aluminum
353	Machine screw, pan hd, 18-8 SST, (4 req'd)
366	Controller Mounting Plate, 18-8 SST
367	Support bracket ass'y, zinc/brass
368	Link ass'y, 18-8 SST (2 req'd)
369	Process indicator adj ass'y, aluminum/SST/brass
370	Set pt indicator ass'y, aluminum/SST/brass
371	Pivot pin, S30200 (302 SST) (2 req'd)
372	Washer, plain 18-8 SST (4 req'd)
374	Pointer and bracket ass'y, aluminum/steel
375	Set pt indicator ass'y, A93003 (aluminum) for controllers w/remote set pt for controllers w/o remote set pt
376	Dial bracket, G10080 (steel)
377	Dial bracket, G10080 (steel)
378	Screw, self-tapping, 18-8 SST (2 req'd)

Auto/Manual Station (suffix letter E) (figure 6-5)

Key	Description	Part Number
273	Auto/manual station	
274	Lower loader ass'y, aluminum	
275	Spring seat screw, pl steel	
276	Valve plug spring, K08500 (pl steel)	
277*	Valve plug, 18-8 SST	18A2878X012
278	Tube, plastic	
279	Ball, SST	
280	Ball seat, nitrile (2 req'd)	
281	Diaphragm ass'y, nitrile/aluminum	
282	Loader ass'y, aluminum/plastic	
283	Range spring, SST	
284	Range spring cup, pl steel	
285	Spring adj screw, pl steel	
286*	Retaining ring, pl steel	18A2903X012
287	Loader knob, plastic	
288	Machine screw, rd hd, 18-8 SST (2 req'd)	
289	Machine screw, fill hd, 18-8 SST (4 req'd)	
290	Machine screw, fill hd, S30200 (302 SST) (2 req'd)	1K318838992

*Recommended spare parts

Figure 6-5. Auto/Manual Station

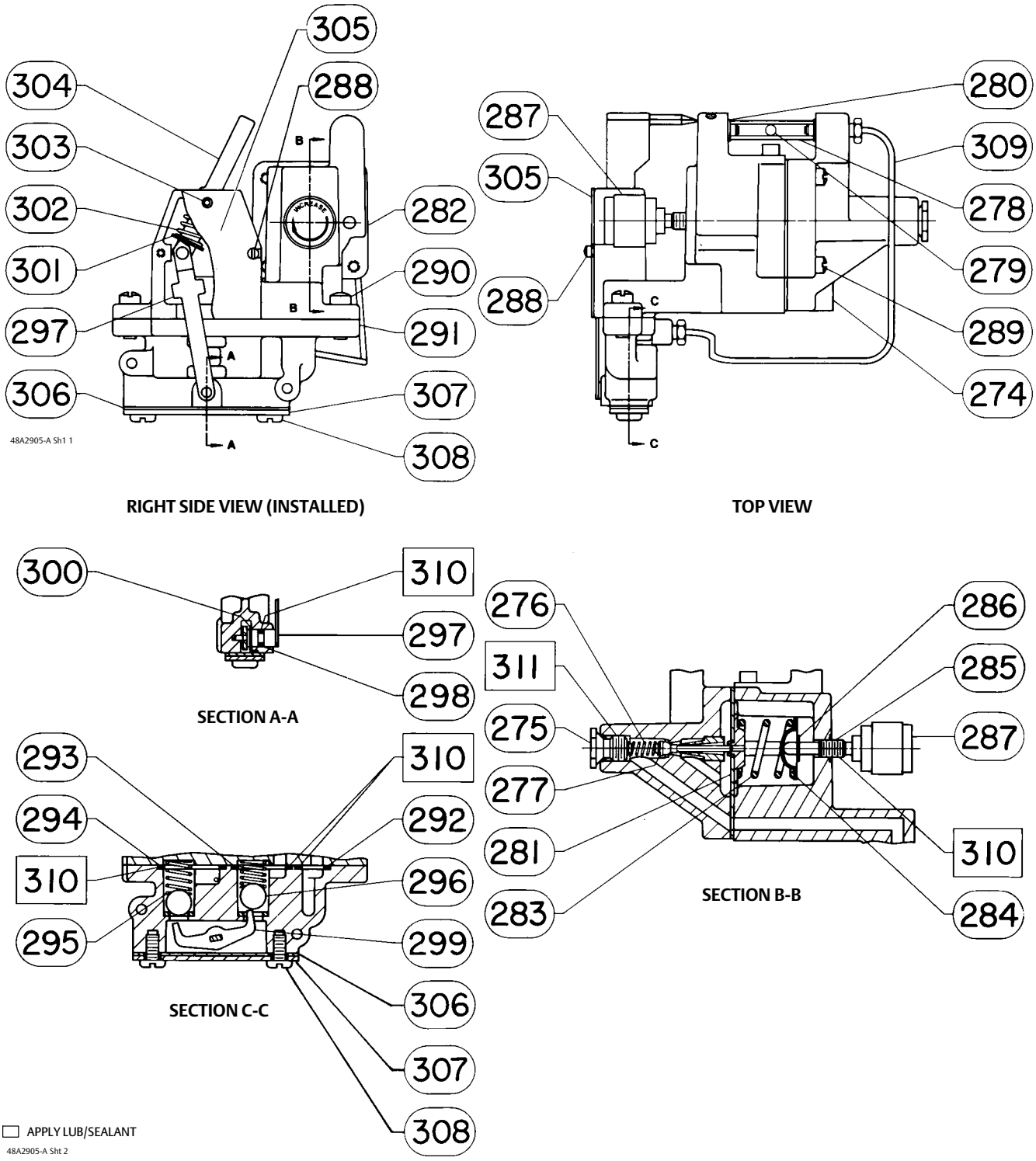
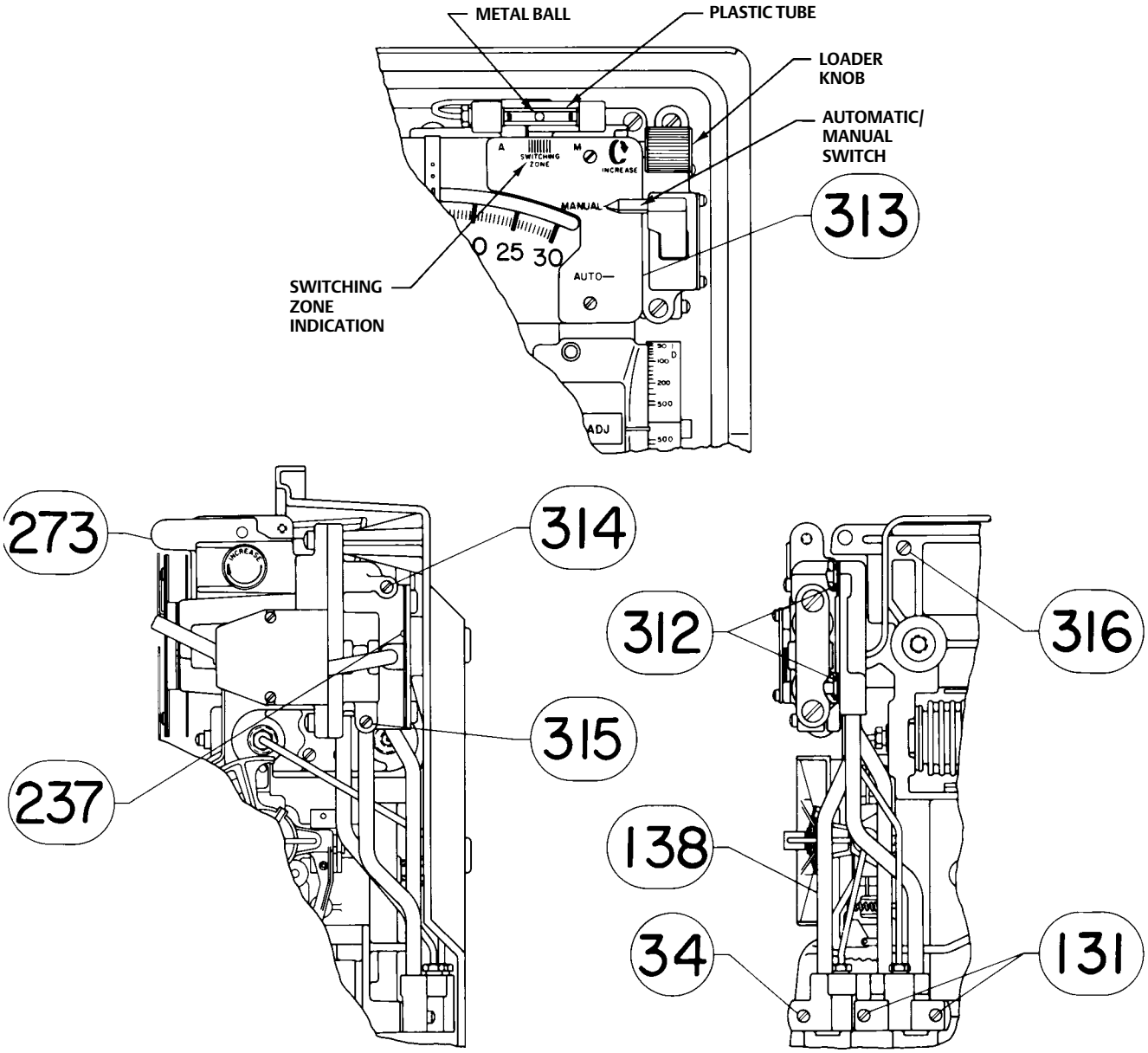


Figure 6-5. Auto/Manual Station (Continued)



Key	Description	Part Number
291	Switch body ass'y, aluminum/nitrile	
292*	O-ring, nitrile	1U2398X0032
293*	O-ring, nitrile	11A8741X052
294*	O-ring, nitrile	13A1584X012
295	Switch body spring, K08500 (pl steel) (2 req'd)	
296	Ball, SST (2 req'd)	
297	Lever ass'y, SST	
298*	O-ring, nitrile	1E222606992
299	Rocker, A96061 (aluminum)	

*Recommended spare parts

Key	Description	Part Number
300	Clip, SST	
301	Lever spring seat, SST	
302	Lever spring, K08500 (pl steel)	
303*	Groove pin, SST	16A6380X012
304	Switch lever, polycarbonate/SST	
305	Switch lever cover plate, aluminum/chromate	
306*	Closing plate gasket, chloroprene	18A2898X012
307	Closing plate, SST	
308	Machine screw, pan hd, 18-8 SST, (2 req'd)	
309	Tubing ass'y, SST	
310	Lithium grease (not furnished with controller)	
311	Anti-seize sealant (not furnished with controller)	
312*	O-ring, nitrile (3 req'd)	1P8453X0022
313	Auto/Manual Scale, polycarbonate	
314	Machine screw, fill hd, 18-8 SST	
315	Machine screw, fill hd, 18-8 SST	
316	Machine screw, SST	

Controller Mounting Parts

Note
Contact your Emerson Process Management sales office for any additional parts required for controller mounting.

Note
Specify quantity of fittings required.

Fittings

For 1/4 NPT tubing
Connector, brass
Elbow, brass
For 3/8 NPT tubing
Connector, brass
Elbow, brass

*Recommended spare parts

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